The Allen Consulting Group

A Study of International Science and Technology Policies and Programs

Final Report

August 2003

Report to Department of Education, Science and Training

The Allen Consulting Group

The Allen Consulting Group Pty Ltd
ACN 007 061 930

Melbourne
4th Floor, 128 Exhibition Street
Melbourne VIC 3000
Telephone: (61-3) 9654 3800
Facsimile: (61-3) 9654 6363

Sydney
3rd Floor, Fairfax House, 19 Pitt Street
Sydney NSW 2000
Telephone: (61-2) 9247 2466
Facsimile: (61-2) 9247 2455

Canberra
Level 12, 15 London Circuit
Canberra ACT 2600
GPO Box 418
Canberra ACT 2601
Telephone: (61-2) 6230 0185
Facsimile: (61-2) 6230 0149

Perth
Level 25, 44 St George's Terrace
Perth WA 6000
Telephone: (61-8) 9221 9911
Facsimile: (61-8) 9221 9922

Online
Email: acgcba@allenconsult.com.au
Website: www.allenconsult.com.au

Table of Contents

Abbreviations

AAD	Australian Antarctic Division
AAS	Australian Academy of Science
ABARE	Australian Bureau of Agricultural and Resource Economics
ACIAR	Australian Centre for International Agricultural Research
ACST	(Prime Minister's) Advisory Council on Science and Technology (Canada)
ACT	Australian Capital Territory
AFF	Agriculture, Fisheries and Forestry Portfolio
AGO	Australian Greenhouse Office
AIMS	Australian Institute of Marine Science
AIST	National Institute of Advanced Industrial Science and Technology (Japan)
ANSTO	Australian Nuclear Science Technology Organisation
APEC	Asia Pacific Economic Cooperation
AQIS	Australian Quarantine and Inspection Service
ARC	Australian Research Council
ASRC	Australian Standard Research Classification
ATNF	Australian Telescope National Facility
ATSE	Australian Academy of Technological Sciences and Engineering
AWI	Australian Wool Innovation
BA	Biosecurity Australia
BRS	Bureau of Rural Sciences
CERN	Centre European pour la Résearche Nucléare (European Laboratory for Particle Physics)
CISET	Committee on International science, Engineering and Technology (US)
COST	Committee on Science and Technology (Europe)
CRC	Cooperative Research Centre
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CSTP	Council on Science and Technology Policy (Japan)
DAAD	German Academic Exchange Program
DAFF	Department of Agriculture, Fisheries and Forestry
DCITA	Department of Communication, Information Technology and the Arts
DEST	Department of Education, Science and Training
DFAIT	Department of Foreign Affairs and International Trade (Canada)
EA	Environment Australia

EEA	European Economic Area (15 EU countries plus the three EFTA countries (Iceland, Liechtenstein and Norway)
EMBO	European Molecular Biology Organisation
ESA	European Space Agency
ESF	European Science Foundation
ESRF	European Synchrotron Radiation Facility
EU	European Union
FEAST	Forum for European-Australian Science and Technology Cooperation
FRRF	Fisheries Resources Research Fund
GAO	General Accounting Office (US)
GBRMPA	Great Barrier Reef Marine Park Authority
GERD	Gross Expenditure on Research and Development
GRDC	Grains R&D Corporation
GPRA	Government Performance and Results Act (US)
GTEM	Global Trade and Environmental Model
IAP-IST	Innovation Access Programme – International Science and Technology
ICT	Information and Communications Technology
IEA	International Energy Agency
INCOPOL	International Co-operation Policies of the EU/EEA Countries in Science and Technology
IP Australia	Intellectual Property (Office)
IRAP/NRC	Industrial Research Assistance Program of the National Research Council of Canada
ISAT	International Science and Technology Linkages Fund (NZ)
ITR	(Department of) Industry, Tourism and Resources
JSPS	Japan Society for the Promotion of Science
JSTC	Japan Science and Technology Corporation
KEK	High Energy Accelerator Research Organisation (Japan)
KOSEF	Korean Science and Engineering Foundation
MECU	Million European Currency Units
MEXT	Ministry of Education, Sports, Culture, Science and Technology (Japan)
MNRF	Major National Research Facility
MOST	Ministry of Science and Technology (Korea)
MoRST	Ministry of Research, Science and Technology (New Zealand)
NASA	National Aeronautics Space Agency (US)
NEA	Nuclear Energy Agency
NCGP	National Competitive Grants Program (of the Australian Research Council)

NHMRC	National Health and Medical Research Council
NOO	National Oceans Office
NRC	National Research Council (Canada)
NSB	National Science Board (US)
NSERC	National Science and Engineering Research Council (Canada)
NSF	National Science Foundation (US)
NSTC	National Science and Technology Council (Korea and US)
NSW	New South Wales
NT	Northern Territory
NZ	New Zealand
OECD	Organisation for Economic Cooperation and Development
OMB	Office of Management and Budget (US)
OSTP	Office of Science and Technology Policy (US)
PNG	Papua New Guinea
Qld	Queensland
R&D	Research and Development
RTD	Research, Technological Development and Demonstration
RDC	Rural R&D Corporation (Australia)
RIKEN	Institute of Physical and Chemical Research (Japan)
RIRDC	Rural Industries R&D Corporation
SA	South Australia
S&T	Science and Technology
SKA	Square Kilometre Array
STC	Office of Science and Technology Cooperation, US State Department
SME	Small and Medium-sized Enterprise
SNF	National Science Foundation (Switzerland)
Tas	Tasmania
UK	United Kingdom
US	United States of America
Vic	Victoria
WA	Western Australia

Executive Summary

International S&T supports economic growth

All countries recognise the importance of international science and technology (S&T) cooperation as a key element of national science and innovation systems. In a world of increasing globalisation, advances in science and technology can be sourced from all corners of the globe. These advances provide opportunities to enhance national economic growth, employment, and social benefits.

Governments are key players in international S&T

Governments are key players in international S&T. There are many government-to-government bilateral S&T cooperation agreements and all governments fund research and development (R&D) including international research cooperation.

Australia is dependent on the rest of the world's S&T

Because Australia invents only a very small fraction of our technological requirements, we are very dependent on the rest of the world for the technology that underpins the success of our economy and our living standards. International S&T is essential to keeping Australia's scientists and engineers in touch with developments at the leading edge of their fields of research.

Relying on technological imports is not an option

Without this, Australia would be a technological price taker, forced to pay whatever prices were demanded. The country would have to produce ever increasing volumes of commodity exports to pay for technological imports and would be at risk of being denied access to some technologies critical to our defence, competitiveness and welfare requirements.

Australia's location makes international S&T cooperation particularly important

Australia's distance from the rest of the industrialised world makes S&T cooperation relatively more important for Australia than, for example, countries in Europe where very large concentrations of research effort are located within two hours travel by air. In addition, cooperation in S&T has been a major ongoing activity of the EU and has been well funded. As a consequence, there is less motivation for EU countries to seek S&T collaboration with countries such as Australia.

Analysis of Australia's International S&T Activity

Understanding the characteristics and size of Australia's international S&T is a pre-requisite to policy development

Given the importance of international S&T to Australia, understanding the size, breadth and other characteristics of our international S&T cooperation activities is a prerequisite for policy review and development. Undertaking such an analysis for Australia is not an easy task as responsibility for science and innovation is spread across many government Departments and Agencies. To develop a picture of international S&T in 'pluralist' science and innovation systems requires detailed 'bottom up' data collection and analysis.

The availability of data has placed some constraints on this analysis

This study is the first such analysis undertaken in Australia. It follows recent US and European studies. This study has had to rely on information in the possession of research granting and performing agencies. As an example of some of the limitations encountered, most granting bodies do not ask applicants to provide details of their proposed international S&T activities. Even when such information is provided it is not necessarily collected in a way that facilitates the sort of analysis needed to support policy development. In addition, for the years selected for analysis some research performing agencies did not track the extent to which their staff worked on international projects. The study team has had to develop strategies to overcome a lack of data for some Agencies and Programs.

Data has been gathered by program and aggregated to obtain figures by Portfolio

In the first instance, the 'bottom up' process developed here involved analysing program expenditure (sometimes by reviewing successful grant applications). Program data were aggregated to obtain Department and Agency-level data. In a subsequent step Agencies and Department-level data were aggregated to obtain Portfolio-level data. In the final analysis, Portfolio data was combined. For those few Agencies and programs where it was not possible to undertake a bottom up analysis, estimates were developed using other approaches.

Results of Analysis of Australia's International S&T Activity

For 2001-2, $211m of international S&T expenditures were analysed

The results of this analysis of Australian international S&T can be summarised as follows. For the year 2001-2, Commonwealth Government expenditure on international S&T, excluding Defence and industry assistance measures, was approximately $211m. This was approximately 6 per cent of the corresponding total S&T expenditure by the Government. However, these figures underestimate Commonwealth Government expenditure on international S&T.

The US is Australia's most important S&T partner

For those international S&T collaborations that were fully characterised in this study, the US is Australia's most significant partner in terms of S&T collaboration, accounting for 60 per cent of Commonwealth Government funded support. The UK is second highest (14 per cent) followed by multinational collaborations – involving large international organisations and projects.

Research-to-researcher cooperation is the most significant component of Australia's international S&T effort

Most international S&T activities funded by the Commonwealth Government involve Australian researchers working with their foreign peers in researcher-to-researcher collaborations. Other international S&T funding supports aid-related activities and investment in large overseas research facilities.

The ARC is the single biggest source of international S&T funding

The Australian Research Council (ARC) is an important source of funding for Australian researchers involved in international activities. Of those international S&T expenditures characterised in this study, the ARC and the National Health and Medical Research Council together account for more than 25 per cent of the estimated total Commonwealth Government expenditure. Other key Departments and Agencies include the Department of Education, Science and Training and the Australian Centre for International Agricultural Research.

Biological sciences account for a quarter of Australia's international S&T activity

In terms of the fields of research involved in international S&T collaborations, approximately one quarter were in the field of Biological Science and a further quarter was split between Agriculture, Veterinary and Environmental Sciences and Physical Sciences.

CSIRO's international S&T costs are mainly staff time, making analysis difficult.

While CSIRO is active in international S&T activities, the major Commonwealth Government expenditures involved are the wage costs of CSIRO staff participating in international S&T projects. The international S&T expenditures of CSIRO and some other Agencies and Programs have had to be estimated separately.

Conclusions

Other countries provide a broader range of better-funded international S&T programs

An analysis of other countries' polices and programs, particularly priorities and other aspects relevant to S&T cooperation with Australia, shows that all OECD countries are giving increasing attention and support to international S&T cooperation. For many of these countries, their total investment on international S&T is, on a proportional basis, significantly greater than that of Australia. They also offer a broader range of better-funded support mechanisms (Section 9.4).

The importance of international S&T needs better recognition and activity needs to be measured

The importance of international S&T has been clearly demonstrated by this study. This importance needs to be recognised more explicitly across Commonwealth Departments and Agencies. In addition, Departments and Agencies need to take steps to improve their measurement of international S&T activities (Sections 9.1 and 9.2).

Better coordination of international S&T activity is needed

Australia needs to follow the lead of other countries, which have increased their coordination of international S&T activities across government. Many OECD countries have high level coordination mechanisms to ensure that bilateral agreements are managed, overlap between funding sources is avoided, and opportunities to secure national benefits are maximised (Section 9.3).

International S&T should be facilitated by an expanded science counsellor network

An expanded and effective science counsellor network, with suitably qualified staff located in key overseas countries is needed to ensure that Australia's international S&T investments are targeted and provide best value for money. This network needs to be oversighted by the coordination mechanism referred to above (Section 9.9).

Formal S&T agreements with other countries have a role but need to be reviewed

The study concludes that formal S&T agreements with other countries and organisations have a role in underpinning international cooperation, but that these agreements need to be backed with more resources and should be subject to periodic review (Section 9.6).

A range of measures is needed to support the different types of international S&T cooperation

International S&T can serve many objectives. In order to address these different objectives, Australia needs a variety of mechanisms to support international S&T. These should include the different types of support provided by other OECD countries. Generally available support is needed in addition to that provided through peer reviewed research grants (Section 9.4).

Mechanisms are needed to support Australian participation in international megascience projects, assist early career researchers and provide quick responses to new opportunities

Australia needs to expand its mechanisms for supporting large (megascience) projects and international conferences as well as providing more assistance to enable early career researchers to become more engaged with international colleagues. In addition, quick response granting mechanisms are needed to ensure that valuable new opportunities are not lost through delays (Section 9.5 and 9.7).

Greater awareness of intellectual property issues is needed

There is also a need for Australian researchers involved in international S&T activities to be made more aware of the issues regarding intellectual property. This should be done at the time that grants are awarded (Section 9.8).

While much Australian international S&T activity is best practice, policy and program improvements are required

In many respects, Australia appears to compare well with best practice in other OECD countries in relation to its international S&T activities but, as noted above, improvements are required in some policies and programs.

This study is a first step towards a more proactive approach to international S&T

This study is an important first step towards understanding the extent of Australia's international S&T collaboration. The report's analysis provides the basis for evaluating the international dimensions of Australia's S&T policies. Australia is well regarded on the global S&T scene. The proactive policies recommended in this report will ensure that Australia gains maximum value from international S&T collaboration in the future.

Chapter One

Study Objectives, Context and General Approach

This study is aimed at contributing to the development of a stronger Australian science, research and innovation capacity through more effective participation in international science and technology (S&T). Effective participation in global S&T activities is critical to Australia's future social and economic development as a knowledge-based society. Australia only produces about 2 per cent of the world's S&T and can not source all its S&T needs domestically.

1.1 Study Objectives and Terms of Reference

The objective of this study is to identify opportunities, and develop measures, to increase the benefits to Australia from international science and technology cooperation across a range of collaborative activities including participation in large-scale overseas infrastructure. The study provides the first detailed assessment of Australia's involvement in international S&T ever undertaken. It has been undertaken in four parts in accordance with the Terms of Reference.

a) a detailed assessment of the current levels of Australia's international S&T activities. This detailed assessment has included:

i the roles of stakeholders in Australian international S&T activities. Stakeholders include Commonwealth Government, Commonwealth research agencies (CSIRO, ANSTO, AIMS), Australian Research Council, National Health and Medical Research Council, Universities, Cooperative Research Centre's and the Australian Academies of Science and Technological Sciences and Engineering, and Engineers Australia;

ii the level of international collaborative S&T activities undertaken by Australian researchers broken down by:

1. sectors of the Australian S&T community. Sectors include Commonwealth research agencies (CSIRO, ANSTO, AIMS), Universities, Academies, Cooperative Research Centres and private non-profit research organisations;
2. countries/economies;
3. the field of S&T, as defined by the Australian Standard Research Classification (ASRC);
4. geographic location of Australian researchers;
5. researchers' skills and experience;

iii an assessment of the purpose/type of international S&T activities in which Australian researchers participate. Types of activity include:

1. accessing overseas equipment and expertise;
2. accessing large scale facilities;
3. researcher to researcher collaborative projects;
4. bilateral organisation to organisation arrangements;

5. bilateral government to government arrangements;
6. multilateral fora;
7. fellowships and awards;
8. workshops and missions;
9. international S&T programmes;
10. exchanges;
11. international collaborative networks/linkages;
12. conferences and societies;

iv the relationship between domestic linkages and networks with Australian international collaborative activities (including public-private partnerships); and

v the current mechanisms available that support Australian researchers to participate in international collaborative S&T activities and the level and nature of that support. This includes support available both domestically and overseas. This assessment would also include a break down on how support is provided, for example, on a competitive basis, block funding or strategically provided;

b) an analysis of major industrialised economies' international S&T policies and programmes, including a comparison with Australia's S&T policies and programmes and an assessment of the extent to which those countries' economic, legal, cultural and social frameworks facilitate or hinder effective cooperation with Australia. Economies to be analysed are:

i. the European Union and each of its 15 member states prior to the signing of the Treaty of Accession, Athens, 16 April 2003 (Belgium, Denmark, Germany, Greece, Spain, France, Ireland, Italy, Luxembourg, Netherlands, Austria, Portugal, Finland, Sweden, United Kingdom);

ii. Japan;

iii. Korea;

iv. China;

v. US;

c) an assessment of the research priorities and strengths of major industrialised countries and the extent to which they coincide with, or complement, Australia's National Research Priorities; and

d) an analysis of opportunities for collaboration and of options for policies and measures to increase the benefits to Australia from international S&T cooperation. This analysis would include:

i. identifying (including their level and nature) the mechanisms that could increase the effectiveness of the support provided for international collaboration (including participation in and accessing facilities and equipment); and

ii. identification of the impediments/barriers to Australian researchers effective collaboration in international S&T. These impediments may include issues such as ICT, cost of participation in multilateral research infrastructure, funding continuity, and multidisciplinary collaboration.

iii. identifying and assessing the coordination between Commonwealth Government agencies in their decision-making processes and institutional and funding arrangements.

1.2 Study Context

Australia is highly dependent on the rest of the world for much of the S&T knowledge that it needs to maintain its strong economic performance and standard of living. Involvement in international research cooperation helps to maintain the high quality of Australia's own S&T performance. For these reasons it is important that it devotes appropriate resources to international S&T cooperation and ensures that these resources are directed into those areas that will generate the greatest benefits for Australia.

Documenting and analysing Australia's current international S&T activities, policies and programs is a necessary prerequisite to determining how the international elements of our national science and innovation system perform in relation to best practice principles.

This study will contribute to a parallel project, now underway at DEST, that is aiming to map all of Australia's science and innovation activities. The objective of the overall mapping exercise at DEST is to develop an overview of the Australian science, technology and innovation system as a whole, covering funding and expenditure, public and private sector players, roles, linkages, resources and priorities. Australia's performance in key areas of interest will be assessed and compared with that of other advanced countries.

1.3 Approach Adopted

The purpose of this study is to analyse Commonwealth Government expenditure on international S&T at source. The overall goal of the study is to characterise Commonwealth Government-funded S&T activities according to specific criteria including country of collaboration, field of research, type of collaboration and geographic distribution of domestic researchers. The best way to find this sort of detail is to analyse the activities of each organisation that provides funding for international S&T. A similar approach to analysis of expenditures at source was taken in the RAND study for the US, discussed below. An alternative way to estimate activities is through surveys but our timeframe did not allow for this approach. In addition, surveys would not provide the detailed characterisation of activities across all of government required for this study.

While the RAND Institute had access to line-by-line R&D expenditures from Public Accounts, there is no comparable Commonwealth Public Accounts information for S&T or R&D. Hence, it has been necessary to obtain information about international S&T activities from each individual Commonwealth Department and agency. Requests for information included research performing agencies and other organisations that assist the Commonwealth in achieving its international S&T objectives.

1.4 Structure of this Report

This report is structured in the following manner.

- Chapter Two details the methodology undertaken in this study, providing the context with which to assess the data provided by the mapping of international S&T activities in Australia.
- Chapter Three provides a summary of the mapping of Commonwealth funded international S&T activities in Australia.
- Chapters Four to Seven provide details of international S&T activities in a sample of countries and regions:
  - Europe (Chapter Four);
  - the US (Chapter Five);
  - Japan, China and Korea (Chapter Six); and
  - Switzerland, Canada and New Zealand (Chapter Seven).
- Chapter Eight collects and summaries the main findings of the report, incorporating both the results of the mapping of Commonwealth international S&T activities in Australia and the review of activities in other countries. This Chapter also provides best practice principles for international S&T policy.
- Chapter Nine draws together the main conclusions of the study and provides recommendations for government policies and programs in support of international S&T.

The detailed analysis can be found in the Appendices. These are preceded by an Introduction that describes the methodology and definitions used in the study. Appendices A to D provide details of international S&T activities for the following Commonwealth Portfolios:

- Education Science and Training;
- Agriculture, Fisheries and Forestry;
- Health and Ageing; and
- Environment and Heritage.

Appendix E provides details on a sample of other Commonwealth Portfolios, Industry, Tourism and Resources, Foreign Affairs and Trade and Communications, Information Technology and the Arts. Appendix F provides details and analysis of international S&T activities at the University of NSW and uses these to develop estimates of the international S&T activities of all Australian universities.

Chapter Two

Study Methodology

This study's methodology was developed to conduct a detailed mapping of the Commonwealth's international S&T activities, in keeping with the objectives and Terms of Reference, which are listed in the previous Chapter. This Chapter presents an overview of the methodology including both a description of the approach used to map the Commonwealth's international S&T activities, as well as a guide to the analysis of the data. Details of the methodology are provided in the introduction to the Appendices.

2.1 Participants in International S&T

The objective of this study is to characterise international S&T activities funded and undertaken by the Commonwealth. These activities vary in terms of their type (for example, fellowships, conferences and bilateral fora) and the organisations involved in their delivery. Organisations (Agencies and Portfolios) that participate in Commonwealth international S&T include research performing organisations (CSIRO, ANSTO and AIMS) which may be directly involved in international S&T; funding agencies such as the ARC and NHMRC; and divisions within Commonwealth Departmental Portfolios and Agencies, which are more likely to administer the programs and initiatives that support international S&T activities. These various groups, with roles in funding or performing Commonwealth international S&T activities, comprise the group that was targeted for participation in this study.

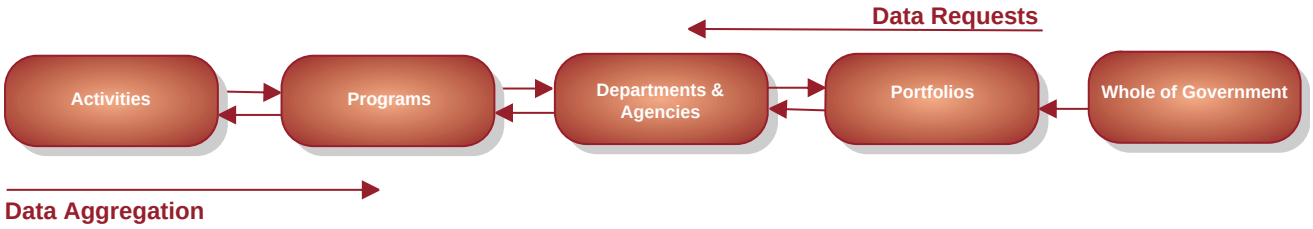
Those Agencies and Portfolios which were expected to exhibit minimal expenditures for international S&T were not targeted for participation in this study. In addition, this study does not include the DSTO or Commonwealth Government industry assistance programs (such as, IR&D tax concession and R&D Start).

In order to capture detailed information on Commonwealth international S&T activities it was necessary to collect data at a level as close to the source of S&T activity as possible. Thus, a 'bottom up' approach was used to capture the details of individual international collaborative activities. These details were then aggregated to build an overall 'whole of government' characterisation of S&T activities. The flow chart in Figure 2.1 illustrates this 'bottom up' approach to collect information by source.

Figure 2.1 also illustrates the 'top down' approach used when making requests for data on Commonwealth international S&T activities. Initial contact was made with senior officials (by DEST), who could then identify key individual staff in Departments and Agencies to participate in the study (more detail on data requests is given in the introduction to the Appendices).

Figure 2.1

INFORMATION FLOWS



Source: The Allen Consulting Group

2.2 Basic Methodological Approach

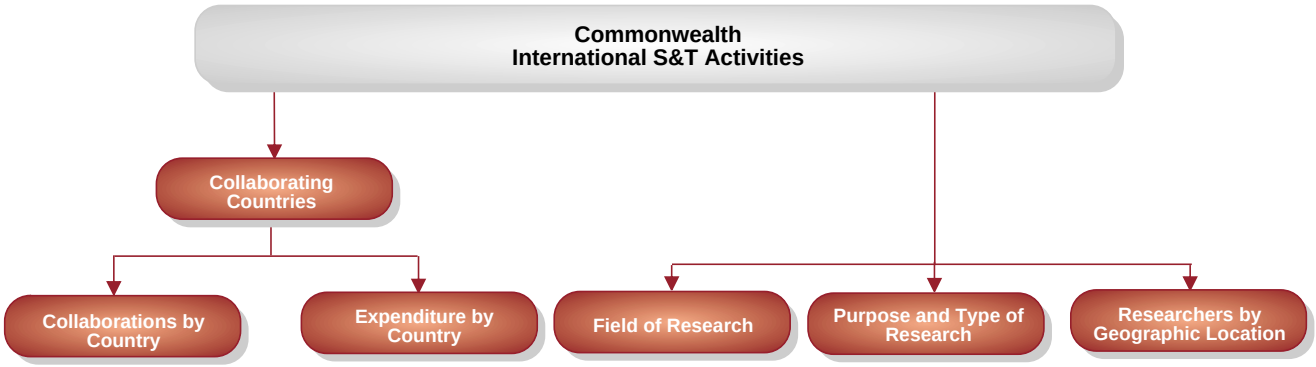
Data Collection

Figure 2.2 illustrates the manner in which data on international S&T activities is characterised. Individual collaborative activities were analysed according to five characteristics: pattern of collaborating countries by number of collaborations; pattern of collaborating countries by expenditure on collaboration; international S&T activities by field of research; international S&T activities by purpose and type of research; and distribution of researchers by geographic location in Australia. In broad terms, the five characteristics listed (and shown in Figure 2.2) can be divided into two stages of analysis:

- In the first stage of analysis the distribution of countries involved in international collaborations is mapped for each S&T activity.
- In the second stage, the activities with international collaborations are characterised by field of research, purpose and type, and the geographic location of researchers in Australia.

Figure 2.2

ANALYSIS PROCESS



Source: The Allen Consulting Group

Data Aggregation

Where data are available, all international S&T activities are characterised according to the five characteristics shown in Figure 2.2. Characterised sets of data for each organisation that contributed to this study are included in the Appendices by Portfolio. In Chapter 3, international S&T activities are aggregated to the Commonwealth level according to Agency and Portfolio. These include the Education, Science and Training Portfolio (non-ARC), the Agriculture, Fisheries and Forestry Portfolio, the Environment and Heritage Portfolio, the ARC, NHMRC and ACIAR.

Data Analysis

For each level of aggregation illustrated in the Appendices and in the Commonwealth summaries provided in this chapter, the analysis of the five characteristics of international S&T activities is shown in a set of five figures. These are:

1) Number of international S&T collaborations by country.
2) Expenditure on international S&T collaborations by country.
3) Field of research of international S&T activities by activity, grant or project.
4) Purpose and Type of international S&T activities by activity, grant or project.
5) Geographic location of researchers based in Australia and involved in international S&T collaborative activities.

2.3 Guide to Interpretation of Figures

International S&T Collaborations by Country – Number and Expenditure

Our analysis of international S&T collaborations by country is illustrated using pie charts. These pie charts are to be interpreted in the following manner:

i) All analysed expenditures for international collaborations refer to Commonwealth Government expenditures.

ii) Collaborations exceed the number of activities, grants or projects mapped because there are many cases where one S&T activity involved more than one overseas collaborator. Hence total number of collaborations is the sum of all collaborators according to their country. For example, if an activity has two collaborators identified in France, then two collaborations for France are recorded for this activity. Since there may be many more researchers involved in overseas teams than the data identify, the resulting number of collaborations characterised can be assumed to be a minimum.

iii) Data were not always available for activities for both number of collaborating countries and for expenditures on these collaborations. Each figure includes all available data and when relevant, explanatory notes on inclusions and exclusions.

iv) Where there is an overseas principal investigator on a collaboration, total Commonwealth expenditures on the activity are assumed to be expenditures on international collaborations. This is also assumed for large multinational projects such as the Global Biodiversity Information Facility (GBIF).

v) Where the international portion of an activity is a lesser component of the overall activity, funding bodies were asked to estimate the international share of expenditure. Where the Study Review Team made the allocation, there are detailed descriptions of how this was done for each set of data in the appendices.

vi) For each activity, project or grant, expenditures are allocated equally to each collaborating country, unless specified otherwise.

vii) Each activity is counted with equal weight. Hence, the GBIF is counted as one S&T activity, as is an NHMRC fellowship. Clearly these two activities are very different in magnitude. Therefore, it is better to combine numbers and expenditures when analysing collaborations, i.e. expenditures give an indication of the weight of a collaboration.

viii) 'Multinational' collaborations refers to collaborative activities with more than six collaborating countries as well as to collaborations with multinational organisations such as the EU, CERN and the multilateral/megascience projects.

ix) The list of countries shown in the key to each pie chart is ranked from the country with the greatest to smallest number of collaborations or largest to smallest expenditure.

x) Countries are shown in ranked order in each pie chart with the ranked order following in a *clockwise* direction.

xi) Where countries have an individual share that is less than 2 per cent of the total, they are combined in groups called 'Other'. In all cases the component countries of 'Other' groups are listed in ranked order in the figure notes. The 'Other' groups of countries are ranked in the pie chart keys, following those countries with shares greater than 2 per cent of the total. In some pie charts there is more than one 'Other' group of countries, for example, Other EU, Other Asia and Other Americas may appear in one pie chart. When this occurs, the groups of 'Others' are ranked in the key from largest to smallest share. They are shown in the pie charts in a clockwise direction, following countries with individual shares greater than 2 per cent.

Figures with Analysis of International S&T Activities by Field of Research

The S&T fields of research covered by this report exclude Defence activities since access to information is restricted. Also excluded are the Humanities and Law, which are covered by ARC grants, for example, but do not fall under the general definition of science and technology fields.

The analysis of international S&T activities by field of research is illustrated using bar charts. These bar charts are to be interpreted in the following manner:

i) The most important feature of the field of research charts is that the distribution of international S&T activities is shown for the eleven fields of research according to the 1993 Australian Standard Research Classification (ASRC) codes. This coding system provides a restricted set of categories that can be applied across all Agencies and Portfolios. Much of the data we received on international S&T activities was not coded and therefore we needed to assign codes in the most consistent way for comparison purposes. If all funding organisations used the same method, comparison according to research field would be facilitated. The ARC uses the 1998 ASRC coding system, which uses a finer coding system for Fields of Research. In future, having all activities across the Agencies and Portfolios coded according to the 1998, ASRC system would be ideal.

ii) Since not all organisations ask for or allocate field of research codes, assumptions have been made in allocating ASRC codes for fields of research. These are discussed in the Appendices.

iii) The total number of fields of research analysed shown in a bar chart is not directly comparable with total number of activities or collaborations for a particular portfolio, program or agency, shown in the related analyses (i.e. analysis of international S&T by country, purpose and type and geographic location). This is because there are international S&T activities, which cannot be characterised by a single field of research, for example, for some bilateral or multilateral for a. In addition, in some cases, data were unavailable.

Figures with Analysis of International S&T Activities by Purpose and Type

Our analysis of international S&T activities by purpose and type is illustrated using bar charts. These bar charts are to be interpreted in the following manner:

i) The most important feature of the purpose and type charts is the distribution of international activities characterised across twelve purposes and types of activities (the list of purposes and types were derived from the Terms of Reference, see Chapter 1).

ii) The total number of purposes and types of activities analysed in a bar chart is not directly comparable with totals shown for other figures that comprise an analysis of a particular portfolio, program or agency (i.e. country, field of research and geographic location). This is because a particular activity may have just one or multiple purposes and in some cases, data were unavailable.

Figures with Analysis of International S&T Activities by Geographic Location of Researchers

Our analysis of international S&T activities by geographic location of researchers is illustrated using bar charts. These charts are to be interpreted in the following manner:

i) Each State and Territory has a bar that is split to show the Metropolitan and Non-metropolitan location of researchers (with the exception of the ACT which is all Metropolitan).

ii) These figures show the distribution of researchers' location across the Metropolitan and Non-Metropolitan regions of States and Territories.

iii) The total number of geographic locations analysed in a bar chart is not directly comparable with totals shown in other figures that analyse a particular S&T activity (i.e. in terms of country, field of research, and purpose and type). Instances where information on the location of researchers was not provided or was incomplete are noted in the text.

2.4 Data Issues

Base Year

In general, our approach has been to seek data for the latest available year. In most cases, this has been the 2001-2 financial year. In some cases, calendar year 2002 has been chosen because of agency reporting and data gathering arrangements or because data were available on a grant year basis. In one case, for the DEST Innovation Access Programme–IST, the year 2002-3 has been selected, at DEST's request, because 2001-2 was an atypical year.

Early Career Researchers

Throughout the data collection process we requested information on the number of early career researchers involved in international collaborations. This information was largely unavailable. An effective characterisation of international collaborations according to the number of early career researchers requires better data than are currently available.

Currencies

All dollar figures are Australian dollars unless otherwise indicated. Other currencies have been converted to Australian dollars at conversion rates indicated in the footnotes.

Data Limitations

This study is the most comprehensive analysis ever undertaken of Commonwealth Government involvement in S&T. However there are a few objectives in the terms of reference that have not been achieved or have not been fully achieved, primarily due to data limitations.

The private non-profit sector does not maintain statistics on involvement in international S&T and discussions with the study team indicated that it would not be possible to quantify international components in the wide range of S&T activities that they undertake. However, to the extent that this sector receives funding from Commonwealth Government agencies in support of international S&T it has been characterised in the present study.

Block funding provided by the Commonwealth Government to Australia's universities is used to teach students and support a variety of university activities. This study has estimated the extent that universities are involved in international S&T based on data provided by the University of NSW (see Appendix F).

In some other cases (eg CSIRO, CRCs), the study team has developed estimates where no quantifiable data was available. These cases are identified in the text and the estimated expenditures are included in the totals reported. It should be noted that other recent major studies of international S&T cited in this report have experienced similar data limitation problems.

Chapter Three

Overview of Commonwealth International Science and Technology Collaboration

This Chapter provides the 'whole of government' results and conclusions drawn from the analysis of international S&T activities funded by the Commonwealth Government. This study was restricted by the quality and availability of information on Commonwealth Government-funded international S&T. However, what follows is the first serious attempt to analyse the Commonwealth's role in Australia's international S&T activities in a detailed and meaningful way, based on activities in the 2001-2 financial year.[1]

A detailed analysis of international S&T activities of key Commonwealth Government Departments and Agencies is provided in the Appendices. The information collected and analysed in the Appendices has been aggregated to provide the 'whole of Government' overview presented here.

3.1 Introduction to International S&T

The Commonwealth Government supports international S&T activities through a number of Departments and their Agencies.

In the broadest sense, it could be said that all research requires international collaboration. In reality, the research community is an international community contributing to the advancement of scientific knowledge collectively. Publications arising from research are refereed by international panels of researchers who are current in their fields and therefore, must be both aware of the state of knowledge in their fields, as well as tied into the international research community.

The links, in practice, go beyond researchers keeping up with new publications, since significant time has usually elapsed between a discovery and its publication. Those who are working in a field need to know about current, unpublished research activities and this absolutely demands that researchers communicate with others in their field worldwide. It would not be unreasonable to define this 'communication' as 'collaboration', however this has not been done here. Rather, the method for this study has been to search out explicit descriptions of international collaborations and the collaborators involved and to estimate the expenditures made in support of those collaboration.

As described in Chapter 2, the approach of this study has been to map Commonwealth Government expenditure on international S&T. In some cases, government-funded international S&T leverages funds from offshore sources. In other cases, international S&T activities involving Australian researchers are fully funded from sources offshore. However, the focus in this study is limited to Commonwealth Government-funded international S&T activities.

[1] In a few cases it was necessary to use data for the 2002 grant year, or the 2002-3 financial year.

Current Policy

There is no current Commonwealth Government policy explicitly requiring Departments and Agencies to identify international S&T expenditures or requiring them to encourage international collaborations. However, in 2001 under *Backing Australia's Ability,*[2] the Commonwealth Government allocated an additional $2.9 billion over five years to science and innovation, including additional funding for international S&T through the Innovation Access Program and the Australian Research Council (ARC).

The nature of research undertaken in Australia is one where international collaborations are considered a normal component of this activity. There is no estimate of the value of these collaborations. However, the fact that they have evolved without specific policy encouragement is, in itself, evidence that they are valuable. Otherwise, the collaborations would not be undertaken, given that funds to support S&T are limited.

International S&T collaborations are rarely used as a selection criterion for grants programs. This suggests that many international S&T collaborations are likely to be unreported. Given this situation, it is understandable that Portfolios and Agencies experienced difficulty in meeting data requests for this study. The ARC held the most detailed information on international S&T activities. However, for all Departments and Agencies (including the ARC) a finer examination of international activities (for example, at the level of international grants and fellowships) was necessary to provide the required data.

International Context

To provide a context for international S&T activity, it is useful to examine Australia's expenditure on R&D relative to other countries. Table 3.1 provides such a comparison with countries that are discussed in this report. Countries with a significant investment in R&D may be seen as desirable partners in S&T cooperation, although R&D investment is only one of many factors which influence the selection of international partners.

Table 3.1 shows Gross Expenditure on R&D (GERD), Business Expenditure on R&D (BERD) and Government plus University expenditure on R&D, all expressed as percentages of Gross Domestic Product (GDP). While Australian government expenditure on R&D compares favourably with the OECD country average, Australia's business expenditure on R&D is low, reflecting low levels of activity in Australia by research-intensive sectors such as the aerospace, electronics and pharmaceutical industries.

3.2 Overview of Commonwealth International S&T Expenditure

This study estimates that the Commonwealth spent $211m on international S&T collaboration, in 2001-2 — representing the sum of *fully characterised* S&T expenditure (shown in Table 3.2) and *estimated* S&T expenditure (shown in Table 3.3).

[2] Commonwealth of Australia, 2001, *Backing Australia's Ability – an innovation action plan for the future*. See: http://backingaus.innovation.gov.au/statement/pm_speech.htm

Table 3.1

INTERNATIONAL COMPARISON OF R&D EXPENDITURE - 2000

Country	GERD/GDP (%)	BERD/GDP (%)	GOV+UNI R&D/GDP (%)
Sweden	3.96	3.03	0.93
Finland	3.40	2.41	0.97
Japan	2.98	2.11	0.72
Iceland	2.77	1.56	1.16
United States	2.72	2.04	0.56
Korea	2.65	1.96	0.65
Switzerland	2.63	1.95	0.63
Germany	2.49	1.75	0.74
Total OECD	**2.25**	**1.56**	**0.61**
Denmark (1999)	2.19	1.42	0.75
France	2.18	1.37	0.79
Belgium (1999)	1.96	1.4	0.53
Netherlands	1.94	1.11	0.82
Canada	1.87	1.09	0.77
United Kingdom	1.85	1.21	0.6
Norway	1.64	0.95	0.70
AUSTRALIA	**1.53**	**0.72**	**0.76**
Czech Republic	1.33	0.8	0.53
Ireland	1.15	0.83	0.32
Italy	1.07	0.53	0.53
New Zealand (1999)	1.03	0.31	0.72
Spain	0.94	0.50	0.43
Hungary	0.80	0.36	0.40
Portugal	0.79	0.22	0.48
Poland	0.70	0.25	0.45
Greece (1999)	0.67	0.19	0.48
Turkey	0.64	0.21	0.43
Mexico (1999)	0.43	0.11	0.30

Source: OECD, Main Science and Technology Indicators database, 2003-1.

Fully Characterised International S&T Collaborations

The Portfolios and Agencies listed in Table 3.2 are those which were targeted for participation in this study and were able to meet the request for detailed information on their international S&T activities. The value of international S&T expenditure for these represents an aggregation of their respective programs and initiatives.[3] The total expenditure on international S&T collaboration for the *fully characterised* Portfolios and Agencies is $134.2m.

[3] See Appendices for more detail.

Table 3.2

INTERNATIONAL S&T COLLABORATION EXPENDITURES 2001-2 – FULLY CHARACTERISED

Portfolios and Agencies Analysed	Fully characterised Commonwealth International S&T Expenditure ($ million)
Australian Research Council (ARC) (Appendix A)	53.4
National Health & Medical Research Council (NHMRC) (Appendix C)	26.9
Australian Centre for International Agricultural Research (ACIAR) (Appendix E)	25.6
Education, Science & Training Portfolio (EST — non ARC) (Appendix A)	16.4
Agriculture Forestry & Fisheries Portfolio (AFF) (Appendix B)	7.7
Environment and Heritage Portfolio (Env & Heritage) (Appendix D)	4.1
Total Expenditure Fully Characterised (2)	**134.2**

Source: The Allen Consulting Group
Notes: 1.This table does not include some Agencies (eg CSIRO) for which we have made estimates. See Table 3.3.
2. Totals may not add due to rounding.

The ARC's expenditure dominates and is approximately twice the respective amounts identified for the NHMRC and the Australian Centre for International Agricultural Research (ACIAR). The ARC and NHMRC were found to respectively spend 20 per cent and 11 per cent of their total Commonwealth funding on international S&T collaboration. This difference might be a result of the ARC grant application process which recognises international collaboration.

ACIAR is an unusual participant, since the rationale for its international S&T activities centres upon the provision of development assistance (in the form of the practical application of agricultural research) to less developed countries. The international research collaborations funded by ACIAR go beyond 'aid' and represent an investment in human capital for both Australian and overseas researchers.

The $16.4m expenditure allocated to 'EST non-ARC' includes the international activities of, among others, the Innovation Access Programme – International S&T (IAP-IST) and the Major National Research Facilities Programme (MNRF).

Other international S&T expenditure in the Education, Science and Technology Portfolio could not be characterised, and has therefore been estimated. This includes international S&T collaborations undertaken by CSIRO, Universities, the CRCs and AIMS (see Table 3.3).

International S&T expenditures were also characterised for the Agriculture, Forestry and Fisheries (AFF) ($7.7m), and Environment and Heritage (Env & Heritage) ($4.1m) Portfolios. The amount spent on international S&T by AFF was largely attributed to the activities of the Rural R&D Corporations (RDC). Similarly, activities carried out by the Australian Antarctic Division (AAD) accounted for the majority of expenditure on international S&T by Env & Heritage.

Estimates of Other Commonwealth International S&T Expenditures

The Portfolios and Agencies listed in Table 3.3 are those which were targeted for participation in this study but were unable to provide detailed information on their international S&T activities. The total expenditure on international S&T collaboration for these Portfolios and Agencies has been *estimated* at $76.5m.

Table 3.3

INTERNATIONAL S&T COLLABORATION EXPENDITURES 2001-2 – ESTIMATES

Portfolios and Agencies	Estimated Commonwealth International S&T Expenditure ($ million)
Commonwealth Scientific and Industrial Research Organisation (CSIRO) (Appendix A)	40
Universities (Appendix F)	24
Cooperative Research Centres (CRCs) (Appendix A)	4
Australian Institute of Marine Science (AIMS) (Appendix A)	0.3
Other Portfolios and Agencies (1) (Appendix E)	8.2
Total – estimated S&T expenditure	76.5
Total – characterised S&T expenditure (From Table 3.2)	134.2
Grand Total – characterised and estimated expenditures (2)	**211**

Source: The Allen Consulting Group
Notes: 1. This amount refers to Portfolios and Agencies in Table E 1, excluding ACIAR, which is shown in Table 3.2.
2. Totals may not add due to rounding.

The international S&T activities of two significant research performing organisations, the CSIRO and the Australian Institute of Marine Science (AIMS), as well as those of the CRCs and universities have not been fully characterised. While the expenditure values shown in Table 3.3 provide an indication of the extent of their international S&T activities, it has not been possible to identify the nature of some of these activities.

The lack of detailed information for the CSIRO and the CRCs has important implications for this study's findings. This is because CSIRO and the CRCs are more focused on 'applied' R&D activities, that is, meeting the research and development needs of the community and industry. Their inclusion would have provided details of those international S&T collaborations arising from 'applied' research projects and initiatives, particularly in relation to fields of research such as Information, Computer & Communication Technologies, and Applied Science & Technologies.

Estimates of international S&T activities were based upon the analysis of data from a variety of sources including Commonwealth S&T budgets, case studies and interviews. The method of estimation varied in accordance with the available information.

- The salary component of researchers involved in international S&T makes up a significant component of Australia's total investment in this area. Estimates of the salary component of international S&T collaborations undertaken by CSIRO are not available and neither are estimates available for those university-based researchers whose salaries are not directly covered by a grant in support of international collaborations. Some of these amounts are included in NHMRC and ARC grants, but without better information it is not possible to know the extent to which they have been accounted for. The figure provided for CSIRO is based on an estimate of 10 per cent of staff time in 2001-2.

- The analysis of international S&T at the University of NSW in Appendix F shows that informal international S&T cooperation is a very large part of our total international S&T activity. Some of this informal activity involves indirect (salary) expenditure by the Commonwealth Government. In addition, researchers may have their international airfares paid from private or overseas sources, and the host institution may supplement their Australian salary.

- The $24m estimate for universities is based on a case study of the University of New South Wales. The estimate was also corrected for double counting in regard to ARC and NHMRC grants. International S&T collaboration by university researchers is estimated to amount to 10 per cent of Commonwealth block funding.

- A case study of the Photonics CRC provided a base from which to estimate the value of international S&T collaboration for the entire CRC Programme. The results from the case study were scaled up, according to data from a previous study on the Programme's international linkages. Account was also made for the rate of Commonwealth funding for the CRC Programme, at 30 per cent of total funds.

- AIMS provided their own estimate of expenditure on international S&T. However, in light of the high number of international S&T activities reported by AIMS in 2001-2, the true value of spending on international S&T is likely to be much greater.

Total Commonwealth Expenditure on International S&T Collaborations

Total Commonwealth expenditure on international S&T collaborations is estimated to be $211m in 2001-2 (see Table 3.3). This estimate represents a minimum amount given that:

- only those organisations expected to spend significant amounts of Commonwealth funding on international S&T were targeted for participation;

- participants had difficulty identifying all international S&T collaborations and related expenditures; and

- Commonwealth expenditure for DSTO and for industry innovation support initiatives was not included.

For these reasons it is believed that the actual expenditure is certainly much higher. Nevertheless, the $211m expenditure on international S&T collaboration in 2001-2 represents 6 per cent of the $3.4b[4] in total Commonwealth S&T support,[5] excluding Commonwealth funding for DSTO and industry 'Innovation Support.'

This estimate is the same percentage value as that reported in the US RAND 2000 study of international S&T for FY1997 (see Section 5.3 for details of RAND).[6] While these results invite comparison, it is important be circumspect when discussing the relationship between these two studies' findings.

Both studies underestimate the amount of international S&T collaboration. In the case of the RAND study, only those collaborations that were 100 per cent international were included. Informal activities and those that were not 'budgeted' as R&D were excluded. The RAND study estimates that they failed to capture approximately US$2b – this amounts to additional international S&T spending of half as much again as that characterised.

This study of Commonwealth Government expenditure has not provided a dollar estimate of how much expenditure has been missed, however it is clear that 6 per cent underestimates the total amount of Commonwealth international S&T.

Given the major differences between the US and Australian innovation systems, it is not surprising that the role of international S&T collaboration in these two countries differs. The US system is, by and large, self-sufficient across all fields of S&T. The vast majority of US international S&T in 1997 took place in the US and involved collaborations with researchers from two or more countries, working on big science projects, particularly in the scientific field of aerospace and aeronautics. In contrast, and as this study highlights, the majority of Australian international S&T involved researchers travelling overseas to participate in researcher-to-researcher collaborations. Additionally, a quarter of Commonwealth Government-funded international S&T activities involved the US and a quarter of all collaborations were in the research field of Biological Sciences.

The main point here is the rationale for supporting Commonwealth international S&T must be considered in the Australia context — geographical isolation, strengths and weaknesses of the innovation system and SET-base, and the necessity of access to international sources of knowledge.

[4] Minister Nelson's and Minister McGauran's joint press release, May 13, 2003. See http://www.dest.gov.au/ministers/nelson/budget03/table1.pdf. The total given in the source for *Support for Science and Innovation through the Budget and Other Appropriations* is $4.7b. From this total the following expenditures are subtracted because these have not been characterised for their international collaborations: Expenditures for Defence, Science and Training Organisation (DSTO) ($340.3m) and Innovation Support including IR&D tax concessions ($957m). The resulting total estimate of expenditure on support for science and innovation from this source is $3.4b. This is the base reference of total Commonwealth S&T expenditures used for this study.

[5] Nelson,2003.http://www.dest.gov.au/ministers/nelson/budget03/table3.pdf. The total given in this source for Support for Science and Innovation through the Budget and Other Appropriations is $4.7b. From this total the following expenditures are subtracted because these have not been characterised for their international collaborations: Expenditures for Defence, Science and Training Organisation (DSTO) ($340.3m) and Innovation Support including IR&D tax concessions ($957m). The resulting total estimate of expenditure on support for science and innovation from this source is $3.4b.

[6] RAND, 2000, *International Cooperation in Research and development: An Update to an Inventory of US Government Spending*. The RAND study also use a 'bottom up' approach to estimating international S&T expenditures, however RAND had access to itemised R&D expenditure accounts.

3.3 International S&T Activities in Detail

A summary of findings on the extent and nature of international S&T collaborations financed by the Commonwealth Government is presented in this Section. It begins with a review of the countries involved in Commonwealth funded international S&T, then reviews the nature of international S&T activities by field of research, the purpose and type of activities, and the Australian-based 'home' (or geographic location) of these international S&T activities. These findings are represented in Figures 3.1 through 3.12 and illustrate the characteristics of international collaborations for those Portfolios and Agencies analysed in this study.[7]

International S&T Collaborations – All Countries

Figures 3.1 and 3.2 illustrate the distribution of Commonwealth collaborations worldwide. Figure 3.1 summarises collaborations by number of collaborative links while Figure 3.2 summarises collaborations by expenditure.

A number of observations can be made in relation to these Figures.

- The number of collaborations exceeds the number of projects or grants since each project or grant activity may involve a number of international collaborators.
- Over 100 countries are involved in S&T collaborations funded by the Commonwealth Government.
- The US is the most common partner both in terms of numbers of and expenditure on S&T collaboration (23 per cent and 24 per cent of totals respectively).
- The UK is the second most common partner with 11 per cent of total numbers, and 14 per cent of total expenditure on international S&T collaborations.
- The importance of Multinational collaboration becomes apparent in Figure 3.2, where expenditure on multinational collaborations ($9m) comes third, representing 7 per cent of the total. Multinational activities include different types of collaboration, for example, those involving six or more countries, and those with multilateral organisations such as the EU, CERN and the international telescopes.
- Multilateral collaborations are included in the 'multinational' category. Multilateral collaborations may be formal or informal. Countries may collaborate through formal agreements, as is the case for Antarctic research and the Biological Science researchers in a number of projects including the Global Biodiversity Information Facility (GBIF). In other cases, individual researchers have come together deliberately to collaborate on larger scale research projects, such as mapping the human genome.
- Most of Australia's participation in the EU Framework Programmes is included in the 'multinational' category. However, it appears that some Australian cooperation in EU Programmes has been reported under the individual EU countries involved. A recent FEAST estimate indicates that the total value of Framework 5 Projects and related activities, in which Australia is a participant, is more than $441m.

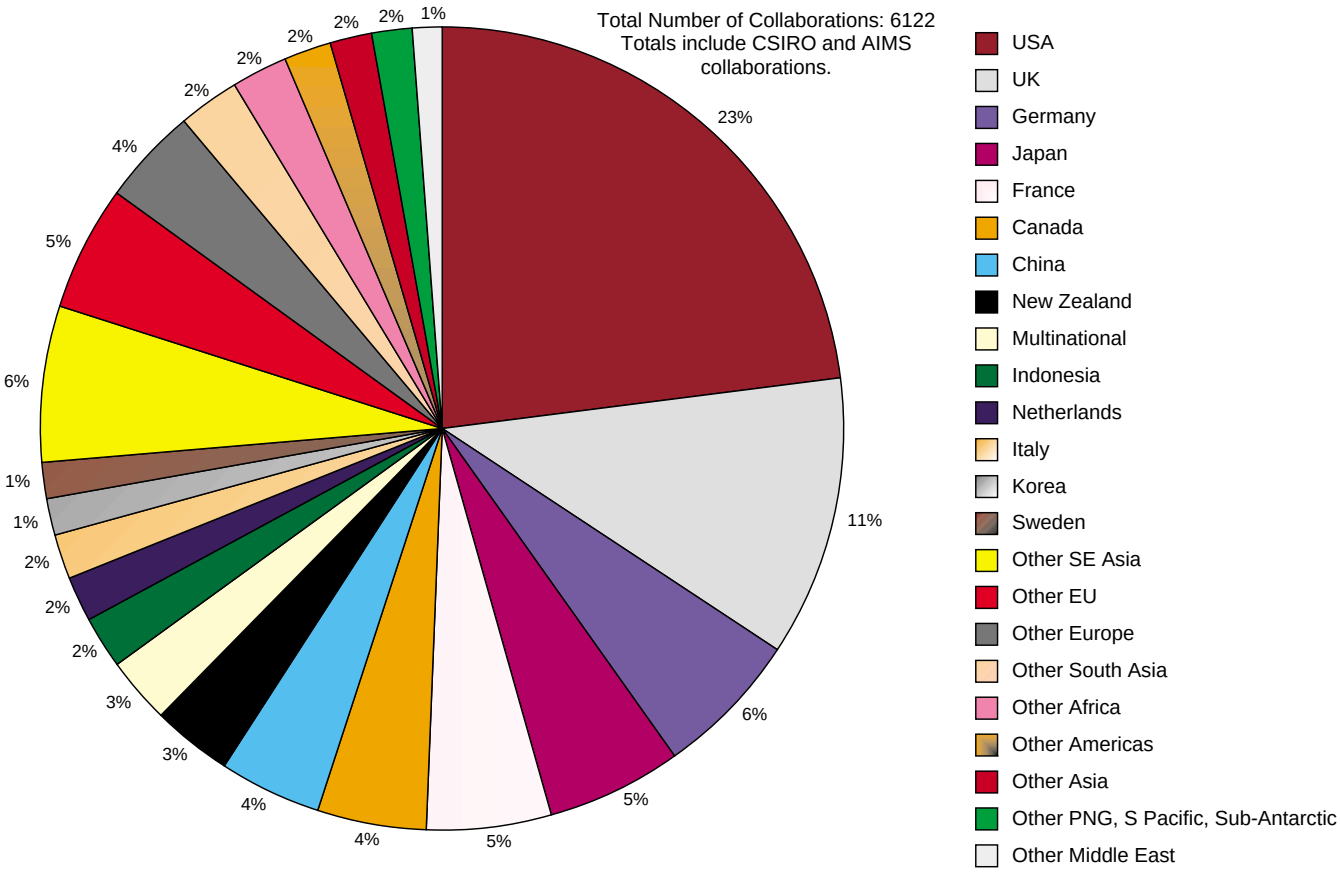
[7] Although unable to provide expenditure estimates, CSIRO was able to provide an estimate of 1,420 international collaborations that were active over the years 2000 to 2002. AIMS estimates it participated in 150 international S&T collaborations in 2001-2. These collaborations are included in the characterisation of the 6,122 collaborations by country illustrated in Figure 3.1. If CSIRO and AIMS collaborations are excluded, there are some minor changes in country rankings and the estimate of the total number of international collaborations funded by the Commonwealth drops to 4,552 collaborations. Details are provided in Appendix A.

(Note that this figure is the total value and not the Australian component - see Table 4.1).

- The ranking outcome reflects the strengths of S&T research efforts of the collaborating countries and maps, by and large, Australia's 'traditional' science links.

Figure 3.1

INTERNATIONAL S&T COLLABORATIONS – ALL COMMONWEALTH

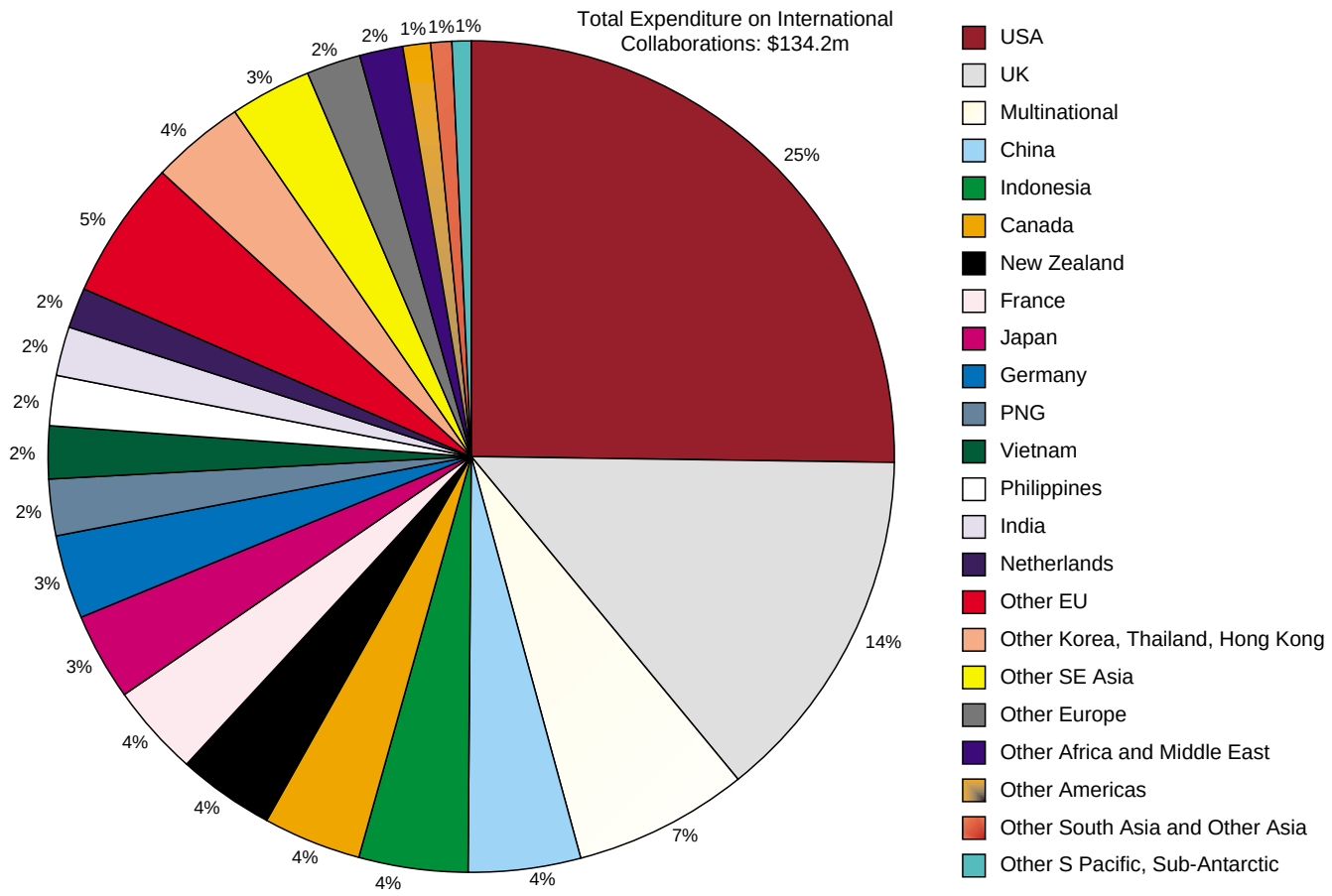


Source: The Allen Consulting Group

Notes:
1. CSIRO and AIMS collaborations are included.
2. Other countries/economies are ranked by number of collaborations. Countries/economies shown individually represent at least 2 per cent of the total expenditure. In some cases rounding results in 1 per cent shares.
3. Data limitations require some groupings such as "Sthn Africa".
4. "EU" includes the EU as an organisation as well as EU countries where funding organisations have not provided a further detailed breakdown.
5. "Multinational" includes multinational organisations such as the OECD, as well as collaborations with more than 6 collaborating countries/economies.
6. **Other SE Asia**: Thailand, Vietnam, Philippines, Malaysia, Singapore, Cambodia, East Timor, Laos, SE Asia, Guam, Myanmar.
7. **Other EU**: Finland, EU, Denmark, Belgium, Spain, Austria, Portugal, Greece, Ireland, Other EU (where no other details were given).
8. **Other Europe**: Switzerland, Russia, Norway, Poland, Turkey, Hungary, Czech Republic, Ukraine, Croatia, Romania, Slovenia, Estonia, Georgia, Iceland, Slovakia, Yugoslavia, Uzbekistan, Macedonia.
9. **Other South Asia**: India, Bangladesh, Sri Lanka, Pakistan, Nepal, Afghanistan, Bhutan, Maldives.
10. **Other Africa**: South Africa, Kenya, Zimbabwe, Nigeria, Tanzania, Mozambique, Madagascar, North Africa, Sthn Africa, Benin, Botswana, Cameroon, Congo, Ethiopia, Malawi, Ghana, Zambia, Senegal, Eritrea, Lesotho, Mauritius.
11. **Other Americas**: Brazil, Mexico, Chile, Argentina, Colombia, Cuba, North America, Costa Rica, Panama, Peru, Bolivia, Ecuador, Uruguay, Venezuela.
12. **Other Asia**: Taiwan, Hong Kong, Asia, East Asia, West Asia, North Korea, Mongolia, Sth Asia.
13. **Other PNG, S Pacific, Sub-Antarctic**: PNG, Fiji, New Caledonia, Solomon Islands, Samoa, Pacific Island Countries, Vanuatu, Tonga, Kirabati, Asia-Pacific, French Polynesia, Sub Antarctic.
14. **Other Middle East**: Israel, Iran, Syria, Oman, Iraq, Lebanon.

Figure 3.2

INTERNATIONAL S&T EXPENDITURES – ALL COMMONWEALTH



Source: The Allen Consulting Group

Notes:
1. Other countries/economies are ranked in order of numbers of collaboration from largest to smallest.
2. Countries/economies shown individually represent 2 per cent of the total expenditure. Rounding may reduce shares to 1 per cent.
3. Other countries are ranked by number of collaborations.
4. Data limitations require some groupings such as "Sthn Africa".
5. "EU" includes the EU as an organisation as well as EU countries where funding organisations have not provided a further detailed breakdown.
6. "Multinational" includes multinational organisations such as the OECD, as well as collaborations with more than 6 collaborating countries.
7. **Other EU**: Sweden, EU, Italy, Finland, Denmark, Belgium, Austria, Spain, Ireland, Greece, Portugal.
8. **Other SE Asia**: SE Asia, Laos, Malaysia, Taiwan, Singapore, East Timor, Cambodia, North Korea.
9. **Other Europe**: Switzerland, Norway, Poland, Russia, Slovenia, Croatia, Hungary, Uzbekistan, Czech Republic, Georgia, Turkey, Slovakia, Iceland, Ukraine, Estonia.
10. **Other Africa and Middle East**: South Africa, Zimbabwe, Mozambique, Israel, Syria, Kenya, Sthn Africa, Oman, Senegal, Madagascar, North Africa, West Asia, Iran, Nigeria.
11. **Other Americas**: Mexico, North America, Brazil, Panama, Costa Rica, Chile, Argentina.
12. **Other South Asia, Other Asia**: Bangladesh, South Asia, Nepal, Pakistan, Sri Lanka, Bhutan, Asia, East Asia.
13. **Other S Pacific, Sub-Antarctic**: Pacific Island Countries, Fiji, Other PNG & Pacific Island Countries, Kiribati, Vanuatu, Tonga, Solomon Islands, Samoa, Sub Antarctic, New Caledonia, Asia Pacific.

Expenditures in Figure 3.2 provide a further characterisation of the extent of collaborations undertaken with overseas partners. Expenditure analysis is useful because it adds a further dimension, or implicit weighting, to the analysis by number of collaborations. For example, the Gemini Partnership collaboration with expenditures totalled $1.6m in 2002, is counted as one collaboration. A Fellowship worth $5,000 is also counted as one collaboration. Hence, when collaborations are analysed by associated expenditures (as an indicator of magnitude), in addition to the number of collaborators (by country), the overall picture of international S&T is improved.

Analysis of Figure 3.2 leads to a number of key observations.

- Expenditure on international S&T collaborations is concentrated among 15 countries. These 'top 15' countries represent 82 per cent of all Commonwealth expenditure on international S&T activities.
- Approximately 70 other countries, together, represent 18 per cent of Commonwealth expenditure on international S&T. On an individual basis, these countries each contribute less than 2 per cent to the total expenditure. As their individual share is minor, these countries are analysed in groups, for example, 'Other Europe.'
- Included in the top 15 group is the multinational category, which itself represents collaborations involving both international organisations as well as activities where six or more countries are involved.
- PNG, Vietnam, the Philippines and India are included among the top 15 in terms of expenditure, but were not represented among the top countries when analysed by number of S&T collaborations. Italy, Korea and Sweden were among top countries by number of collaborations but are not similarly represented in the analysis by expenditure on collaboration.

International S&T Collaborations – Top 15 Countries by Portfolio and Agency

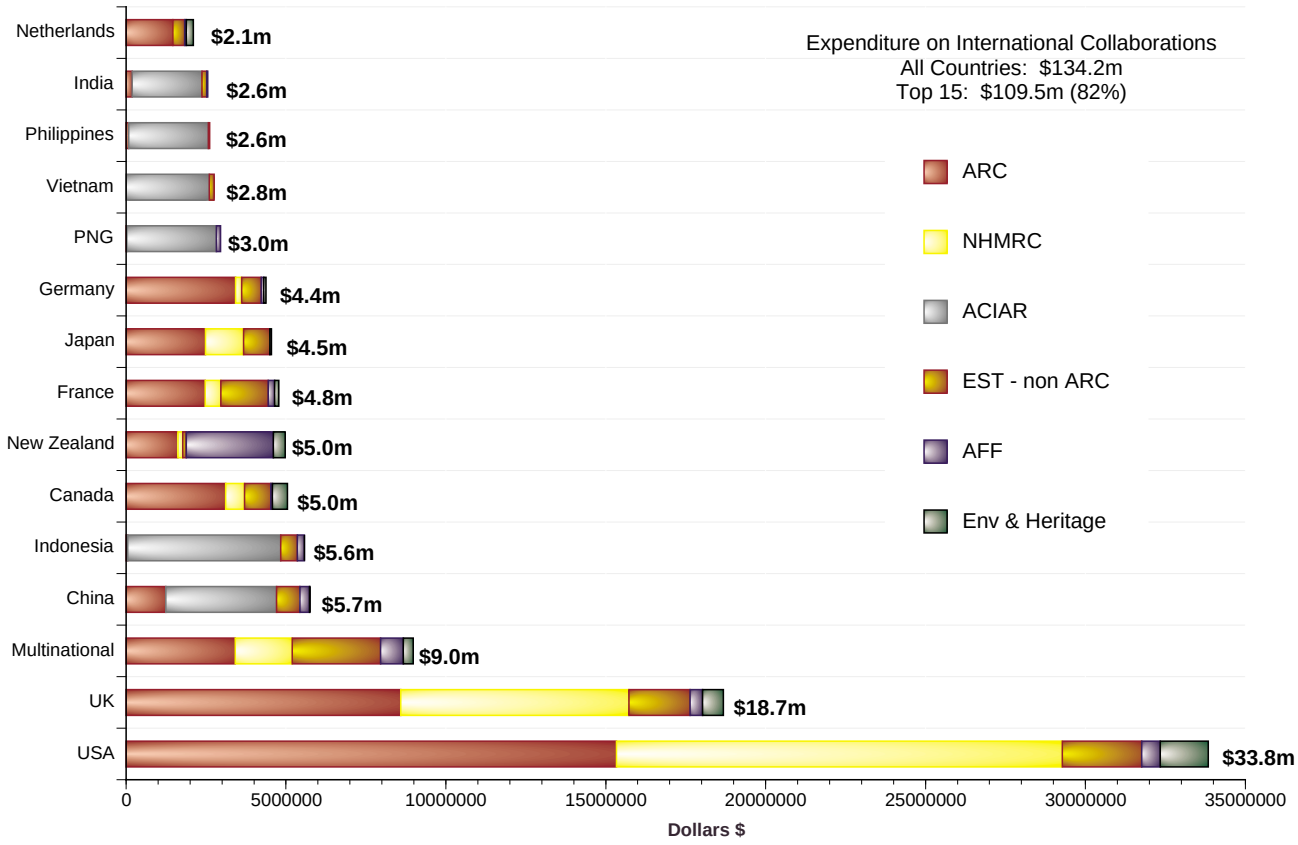
The top 15 countries by expenditure represent $109.5m or over 80 per cent of total Commonwealth expenditure on international S&T collaboration. The following two Figures show an analysis of expenditure for these countries by Portfolio and Agency.

A number of observations can be made in relation to Figure 3.3:

- The US accounts for almost a third of spending among the top 15 countries. Of the $33.8m involved, ARC grants accounted for $15.3m and NHMRC grants for $13.9m.
- The amount of UK expenditure is roughly half that of the US, and displays a similar pattern of expenditure among Portfolios and Agencies.
- The Multinational category has the third highest level of spending, with a relatively smaller proportion of expenditure with the NHMRC when compared with the distribution of funds found for the US and UK.
- ACIAR, with its emphasis on development and aid, contributes the majority of expenditure for China, Indonesia, PNG, Vietnam, the Philippines and India. Clearly, including ACIAR in this analysis has influenced the representation of these countries in the top 15.
- The relatively large share of AFF expenditures in New Zealand is a reflection of S&T collaborations conducted by the RDCs.

Figure 3.3

INTERNATIONAL S&T COLLABORATIONS – EXPENDITURES BY COUNTRY – TOP 15 COUNTRIES



Source: The Allen Consulting Group
Notes: 1. AFF is the Agriculture, Fisheries and Forestry Portfolio including the Research and Development Companies and Corporations.
2. EST is the Education Science and Training Portfolio excluding the ARC, which is show separately.

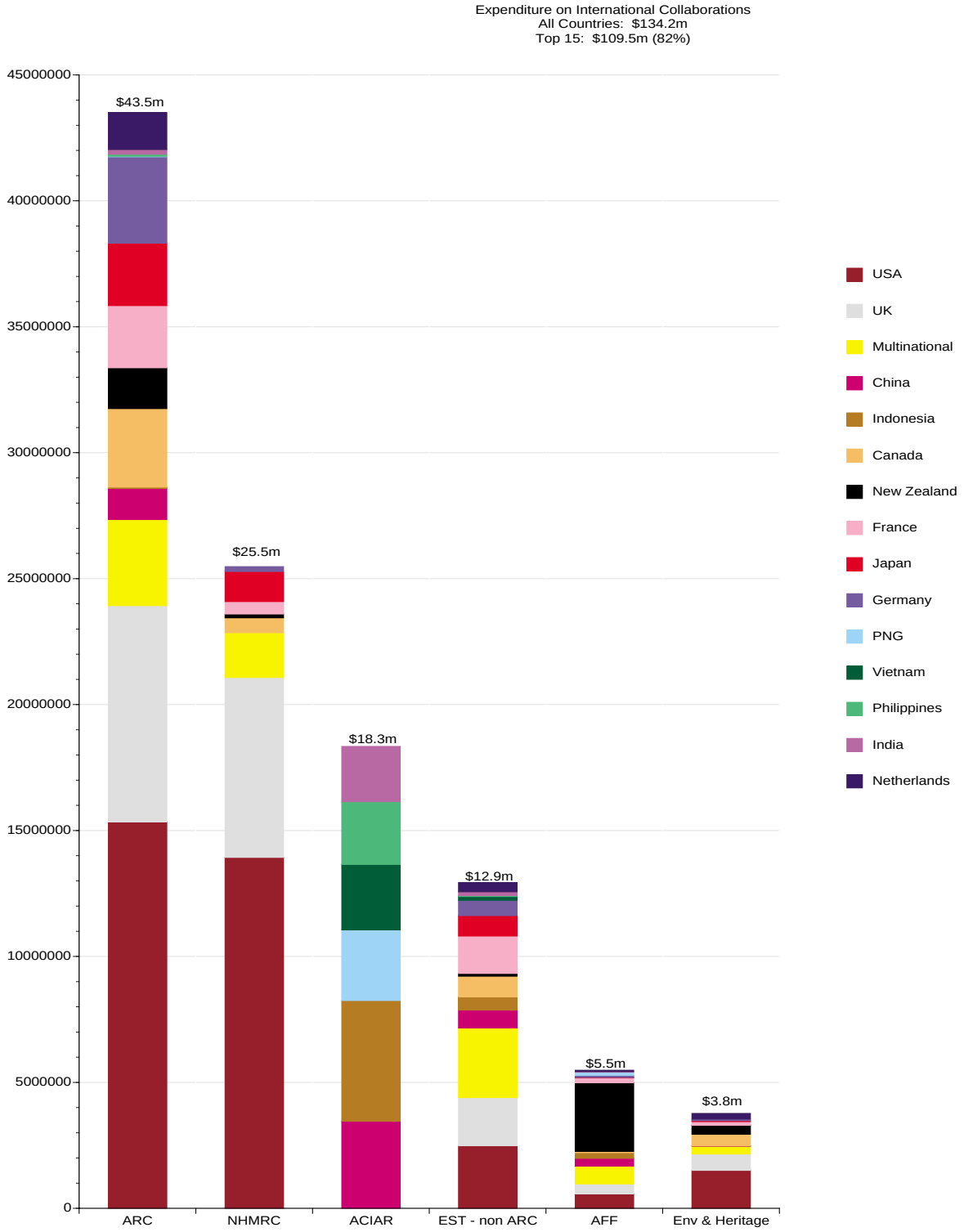
Figure 3.4 shows Portfolio and Agency expenditure on international S&T by the top 15 countries. For this reason care needs to be taken when interpreting the size of the bands in this Figure. It should be noted that the *proportions* of Portfolio and Agency spending with the top 15 countries are as follows:

- Over 80 per cent of the ARC's total international S&T expenditure is undertaken in collaborations with the top 15 countries.
- 95 per cent of the NHMRC's international S&T expenditure is with the top 15 countries.
- Over 70 per cent of ACIAR's international S&T expenditure is in the top 15 countries.
- Over 90 per cent of expenditures on international collaborations by Environment and Heritage Portfolio and almost 80 per cent of EST expenditures are with the top 15 countries.
- Two thirds of AFF's international S&T expenditure is with the top 15 countries and this is dominated by the expenditures on collaborations between RDCs and researchers in New Zealand.

Figure 3.4 illustrates that the dominance of US and UK shares of international S&T activities is primarily focused in the two research agencies, the ARC and NHMRC. These agencies support international S&T collaborations mainly through research grants and fellowships.

Figure3.4

INTERNATIONAL S&T COLLABORATIONS – EXPENDITURES BY PORTFOLIO AND AGENCY – TOP 15 COUNTRIES



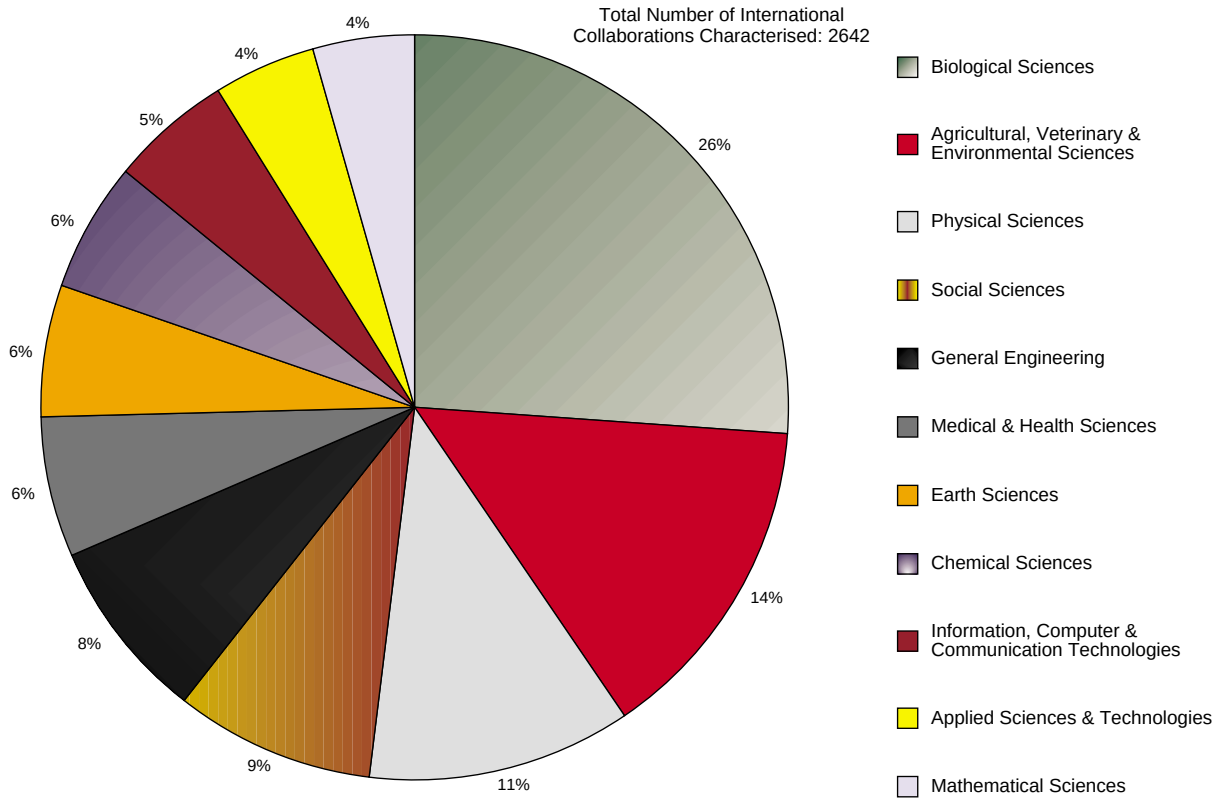
Source: The Allen Consulting Group
Notes: 1. AFF is the Agriculture, Fisheries and Forestry Portfolio including the Research and Development Companies and Corporations.
2. EST is the Education Science and Training Portfolio excluding the ARC, which is shown separately.

Field of Research – All Commonwealth

It was often the case, when characterising S&T activities by field of research, that a single, generic field of research needed to be assigned to an activity that was multidisciplinary in nature. This means that the diversity and number of research fields that are involved in international collaborations is not fully reflected in this analysis. Figure 3.5 shows, for example, that a quarter of the international collaborations characterised are in the Biological Sciences. A finer characterisation would provide more detailed and potentially more useful information about the type of research undertaken within the field of Biological Sciences. This is an issue that needs to be considered in future studies of international S&T collaboration.

Figure 3.5

ALL COMMONWEALTH – ACTIVITIES BY FIELD OF RESEARCH



Source: The Allen Consulting Group

ASRC categories were employed when mapping international S&T activities by field of research. It is important to caution against interpreting the results for fields of research as a representation of how Australian international S&T collaboration relates to National Research Priorities. ASRC categories do not align with Australia's National Research Priorities.[8] Furthermore, this analysis is based primarily on activities conducted in 2001-2 which predate the adoption of the National Research Priorities. An examination of international S&T and research priorities would require the collection of appropriate data. In absence of such data, it is not possible to draw useful conclusions about the extent to which international S&T activities match Australia's National Research Priorities.

[8] See Appendix I for a list of the National Research Priorities.

The analysis of all Commonwealth Government-funded international S&T activities by field of research in Figure 3.5 shows:

- one quarter of Commonwealth funded S&T research activities are in the Biological Sciences, and
- a further one quarter is shared almost equally between Agricultural, Veterinary & Environmental Sciences, and Physical Sciences.

This result reflects the traditional comparative advantage of Australia's expertise in Biological and Agricultural, Veterinary & Environmental Sciences. It may also be the case that the lesser amounts of activities found for more 'applied' fields of research, such as General Engineering (8 per cent) and Applied Sciences and Technologies (4 per cent), is indicative of the role of the Commonwealth Government in Australia's SET-base. While the Commonwealth Government is the primary source of funds for basic research activities, applied research and experimental development are generally funded by the private sector.

This finding for the applied fields of science is also exacerbated by the lack of data for CSIRO and the CRCs. As discussed previously, it is expected that their inclusion would raise the share of the more applied fields. Future studies should endeavour to rectify these issues.

Figure 3.6 shows the distribution of fields of research for Portfolios and Agencies. The Figure shows that:

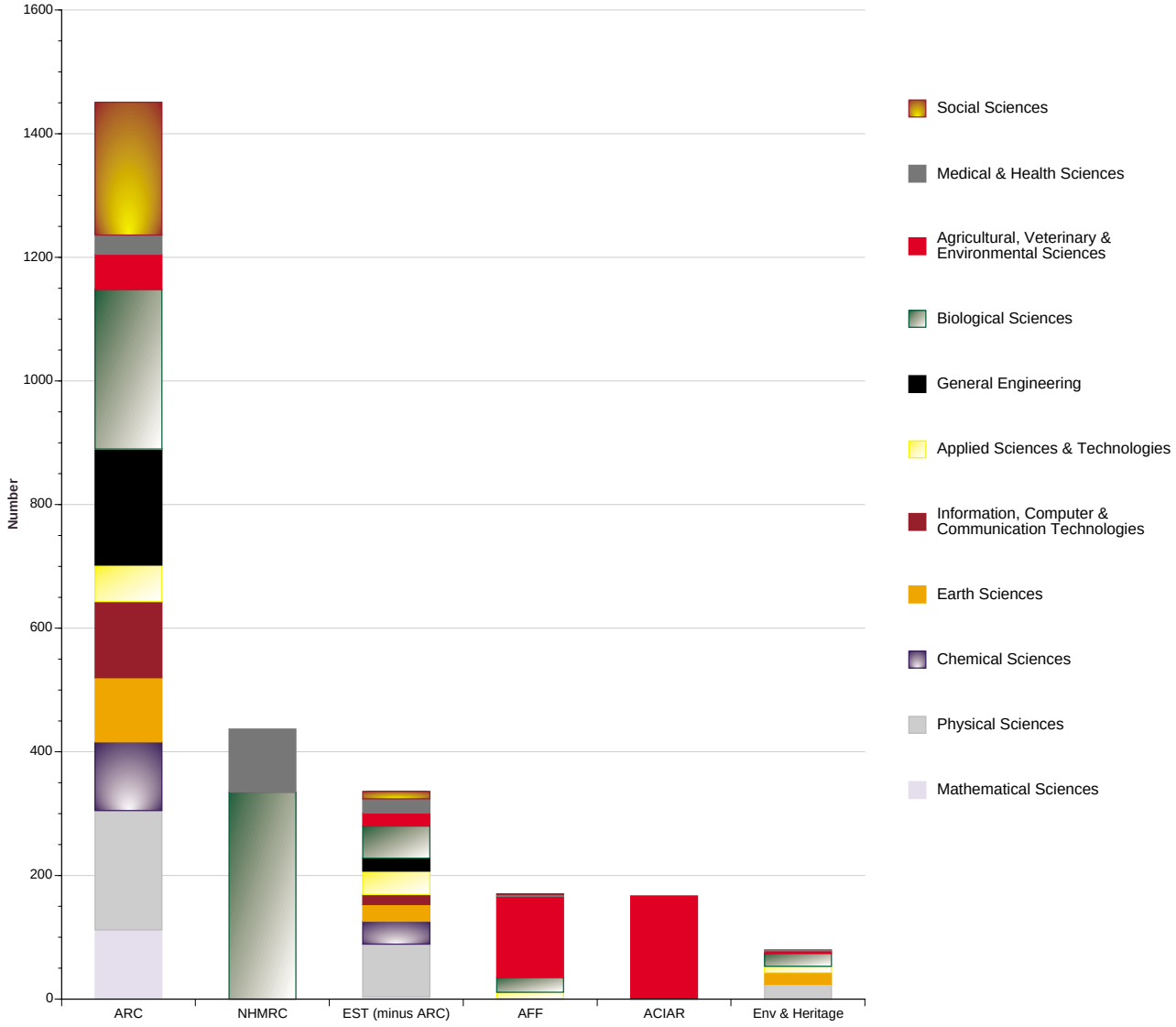
- The ARC has the highest number of international S&T activities characterised by field of research, more than double that of other Portfolios and Agencies; and
- There is an obvious distinction between those organisations with S&T activities in many research fields and those whose S&T activities are concentrated in a few research fields.

The latter finding simply reflects the role and function of the Departments and Agencies concerned and demonstrates that the Commonwealth Government's support for international S&T is delivered in some cases by Departments and Agencies that are 'generalists' and in others with a 'specialist' emphasis on particular fields of research.

- The ARC acts as a 'generalist' provider of research grants — all fields of research are supported in its international S&T activities.
- The EST and Env & Heritage Portfolios encompass a comparatively diverse range of fields of research in their international S&T.
- NHMRC activities are concentrated in Biological Sciences and Medical and Health Sciences.
- AFF is dominated by the international S&T collaborations undertaken by the RDCs in Agricultural, Veterinary & Environmental Sciences, and to a lesser extent in Biological and Medical and Health Sciences.
- ACIAR activities are concentrated Agricultural, Veterinary & Environmental Sciences.

Figure 3.6

INTERNATIONAL S&T ACTIVITIES – FIELD OF RESEARCH BY PORTFOLIO AND AGENCY



Source: The Allen Consulting Group
Notes: 1. AFF is the Agriculture, Fisheries and Forestry Portfolio including the Research and Development Companies and Corporations.
2. EST is the Education Science and Training Portfolio excluding the ARC, which is show separately.

Field of Research – Expenditures by Country for Two Programs

The international S&T activities funded by the ARC and 'EST non-ARC' have the greatest range of research fields. Given this diversity, an additional analysis has been performed on the international S&T activities of two granting programs associated with these organisations, to reveal the pattern of research fields by country. The two programs are:

- The ARC–Discovery Program, for the 2002 grant year, shown in Figure 3.7; and
- EST's IAP-IST Competitive Grants Programme, for 2002-3, shown in Figure 3.8.

The ARC–Discovery Program's international S&T expenditure is $30.7m for 1,028 grants and represents 2,080 collaborations.[9] The IAP-IST Competitive Grants Programme's spending on international S&T is only $3.5m for 42 grants and represents 81 collaborations.[10] These two granting programs also differ in their explicit support for international collaboration, with the IAP-IST Competitive Grants Programme specifically geared to supporting international collaborations, unlike ARC–Discovery.

Figure 3.7 shows the pattern of fields of research by country for ARC–Discovery Program's international activities.[11] This Figure shows that:

- Collaboration with the US involves the highest amount of spending and greatest diversity of research fields. Biological Sciences and Physical Sciences are the dominant research fields.
- The UK is second and followed by Germany. These two countries have a similar distribution of research fields.
- In general, number of research fields represented per country diminishes with diminishing expenditure. For example there are 10 research fields in the US, eight in the UK and Germany, and six in Japan, Canada and France.
- For some countries, there is some evidence of specialisation. For example, Canada has relatively more collaborations in the Earth Sciences and less in General Engineering while Japan has little in Earth Sciences.
- The low amount of expenditure on Medical and Health Sciences is expected as grants in this research field are primarily distributed by the NHMRC. There is minimal expenditure on Agriculture, Veterinary & Environmental Sciences and none for Applied Science and Technologies.

The IAP-IST Competitive Grants Programme is comprised General Grants, EU Framework Funds, the Australia-China Fund for S&T Cooperation and the Australia-Korea Industrial Technology Cooperation Fund. The presence of Physical Sciences in Korea and Communication, Computer & Communication Technologies in China, in Figure 3.8, reflects the influence of the Funds in this Program.

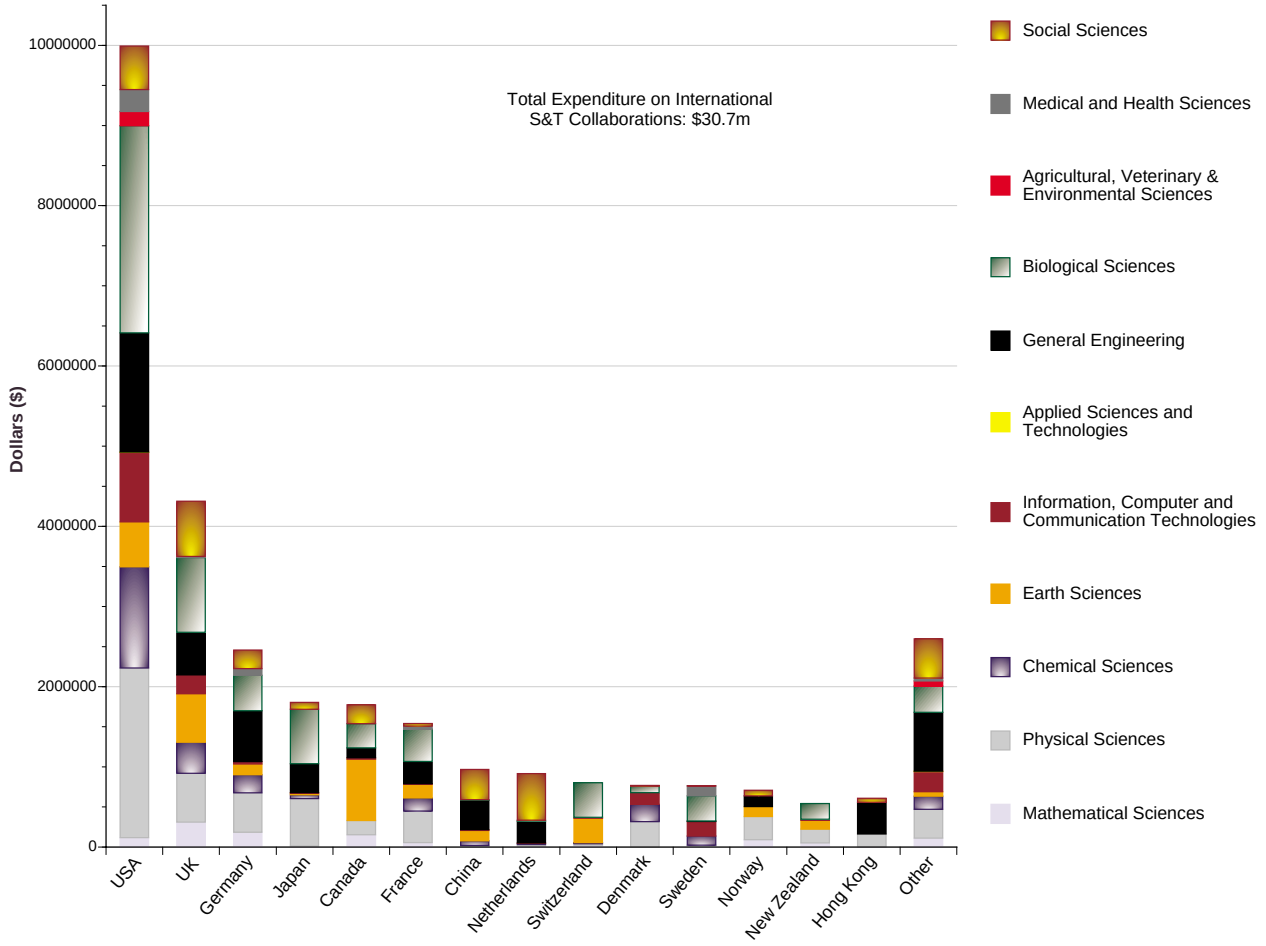
[9] Program details are given in Appendix A in Figures A35, A36 and A37.

[10] Program details are illustrated in Appendix A, Figures A7 and A8.

[11] The pattern of collaboration follows the pattern of total expenditure by country given in Appendix A, Figure A36 and the pattern by field of research given in Figure 3.6 for the ARC as a whole.

Figure 3.7

ARC - DISCOVERY - INTERNATIONAL COLLABORATIONS - EXPENDITURE BY COUNTRY/ECONOMMY AND FIELD OF RESEARCH



Source: The Allen Consulting Group
Notes: 1.Other countries are ranked in order of expenditure from highest to lowest expenditure.
2. Countries shown individually represent at least 2 per cent of total expenditure on international S&T collaborations.
3. Other: Italy, Singapore, Korea, Austria, Poland, Taiwan, Belgium, Spain, Israel, Philippines, Brazil, India, Russia, South Africa, PNG, Uzbekistan, New Caledonia, Costa Rica, Oman, Chile, Georgia, Sri Lanka, Madagascar, Turkey, Argentina, Finland, Iran, Greece, Ukraine, Portugal, Estonia, Pakistan, Cambodia, Nigeria, Thailand, Czech Republic, Indonesia, Malaysia.

In the year analysed, a particularly large grant of $750,00 was made to CSIRO for an environmental sciences collaboration involving the UK, Germany and Slovenia (expenditure ratio 2:2:1). This grant provides a good illustration of the need for longitudinal data, since this one project dominates the distribution of the Agriculture, Veterinary & Environmental Science research field, shown in Figure 3.8. It also contributes a significant component of spending in the three participant countries.

Figure 3.8 also shows:

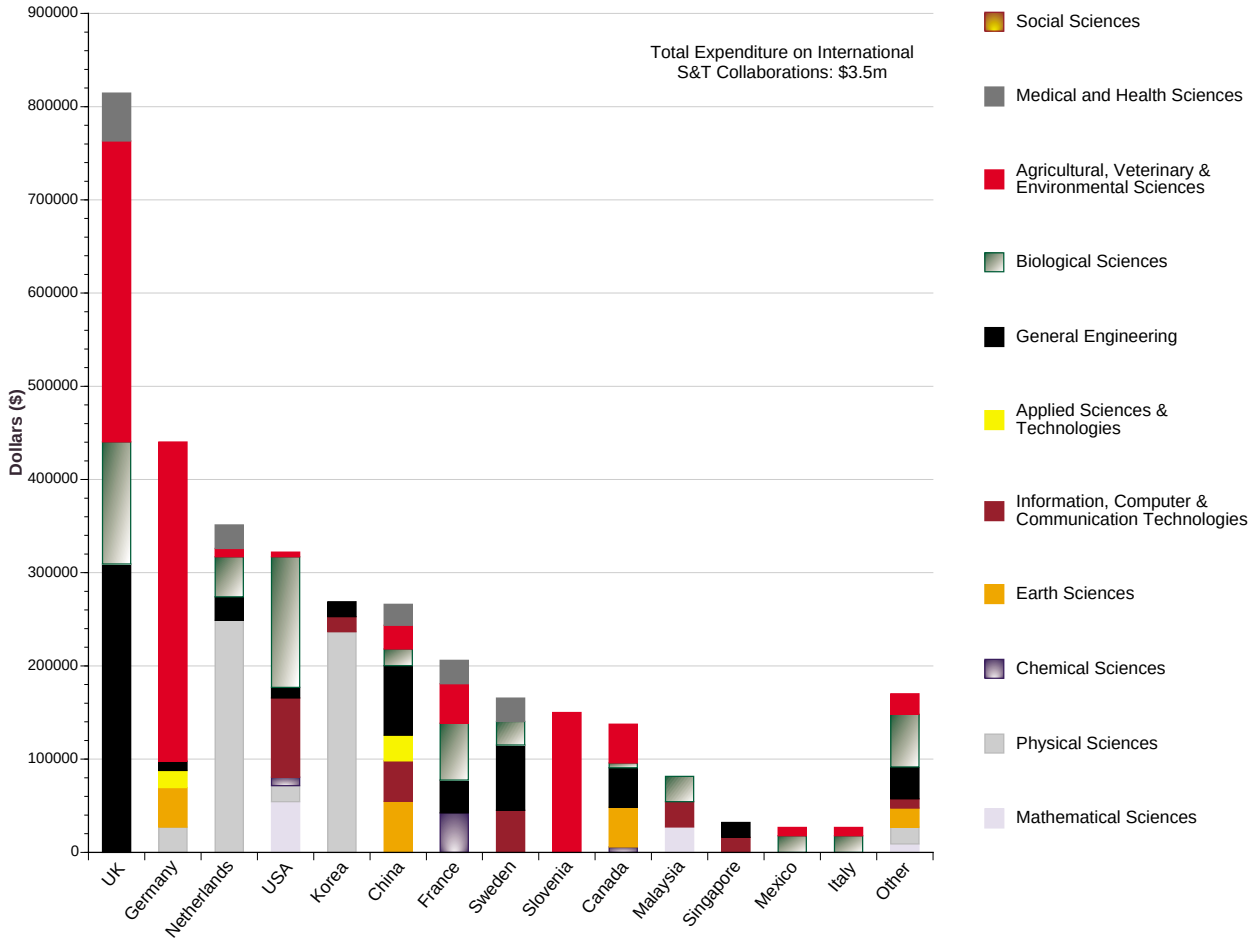
- The UK dominates, particularly in Agriculture, Veterinary & Environmental Sciences and General Engineering.
- Germany is in second place with the majority of expenditure in Agriculture, Veterinary & Environmental Sciences.
- Collaborations with The Netherlands (3rd), and Korea (5th), are dominated by the Physical Sciences research field.

- Information, Computer and Communication Technologies are mostly concentrated in the US.

It is not possible to draw conclusions about the demand for cooperation in specific research fields by country from this analysis. As is clearly shown when considering distribution pattern of research fields by country for the two programs (ARC-Discovery and IAP-IST Competitive Grants), the same country can have different distributions of research fields. For example, the Netherlands is dominated by Social Science and General Engineering for ARC Discovery and by Physical Sciences for Competitive Grants.

Figure 3.8

IAP-IST COMPETITIVE GRANTS – INTERNATIONAL COLLABORATIONS – EXPENDITURE BY COUNTRY/ECONOMMY AND FIELD OF RESEARCH



Source: The Allen Consulting Group
Notes: 1. One Grant worth $750,000, in Agriculture, Veterinary & Environmental Sciences, involved the UK, Germany and Slovenia.
2. Other Countries are all ranked in order of expenditure from highest to lowest expenditure.
3. **Other**: Other Unspecified Countries, Norway, New Zealand, Thailand, Senegal, Czech Republic, Poland, Slovakia, Belgium, Japan.

Purpose and Type of International S&T Activities – All Commonwealth

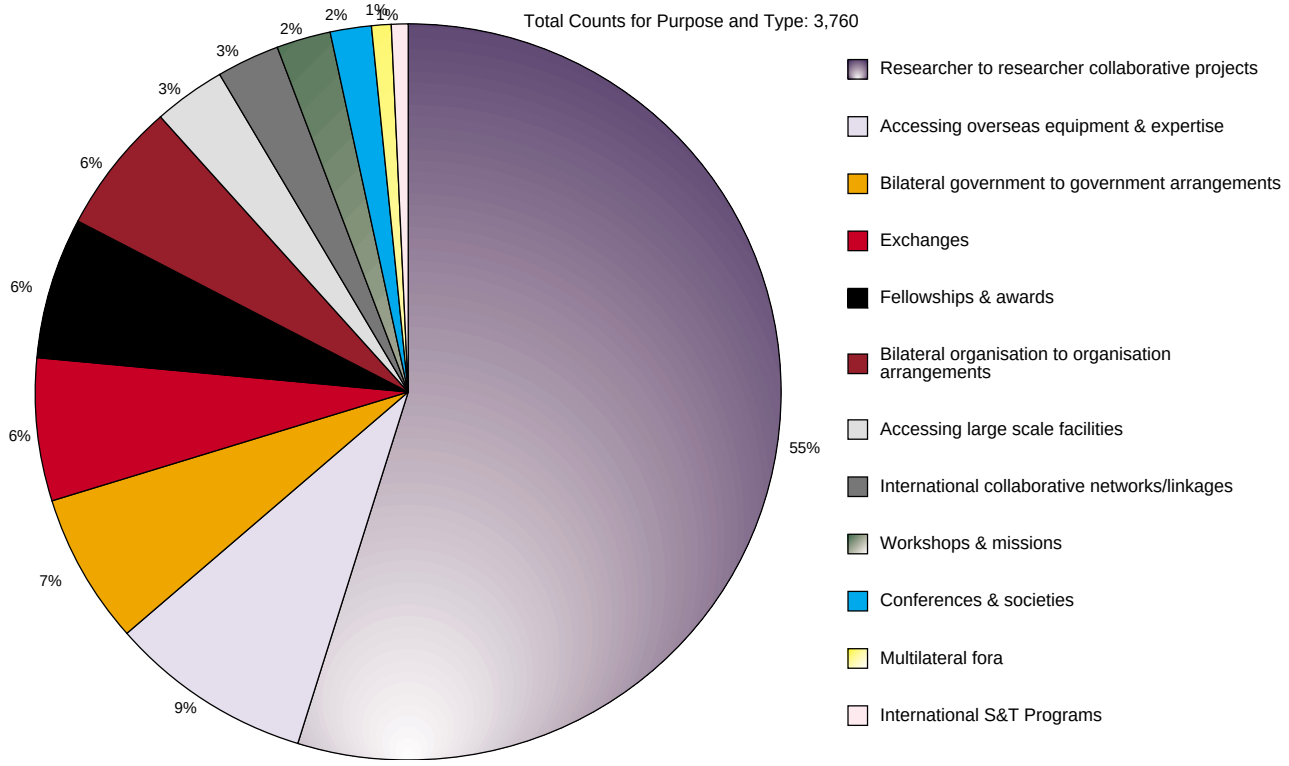
Figures 3.9 and 3.10 illustrate the characterisation of Commonwealth Government-funded international S&T activities by purpose and type. A single S&T activity may be characterised by more than one purpose and type. In all, a total of 3,760 purposes and types were included in the analysis of international S&T activities.

Many agencies and portfolios found it difficult to assign purposes to S&T activities that were undertaken in the past. This provides a further argument for characterising international collaborations at the time they are funded and not later, as has been attempted for this study.

Figure 3.9 shows that over half of all international S&T activities involved 'researcher-to-researcher collaboration'. Since virtually all international S&T collaborations have some aspect of 'researcher-to-researcher collaboration', it is understandable that this purpose dominates. In addition, where there was insufficient information to characterise the purpose of a research grant, it was designated the purpose of 'researcher-to-researcher collaboration'.

Figure 3.9

ALL COMMONWEALTH – ACTIVITIES BY PURPOSE AND TYPE



Source: The Allen Consulting Group

In Figure 3.10, the two research funding agencies, ARC and NHMRC, have a primary purpose of 'researcher-to-researcher collaboration'. EST and AFF show the greatest range of purposes, which may be due to the role of these organisations as administrators of a wide range of programs and initiatives in relation to international S&T.

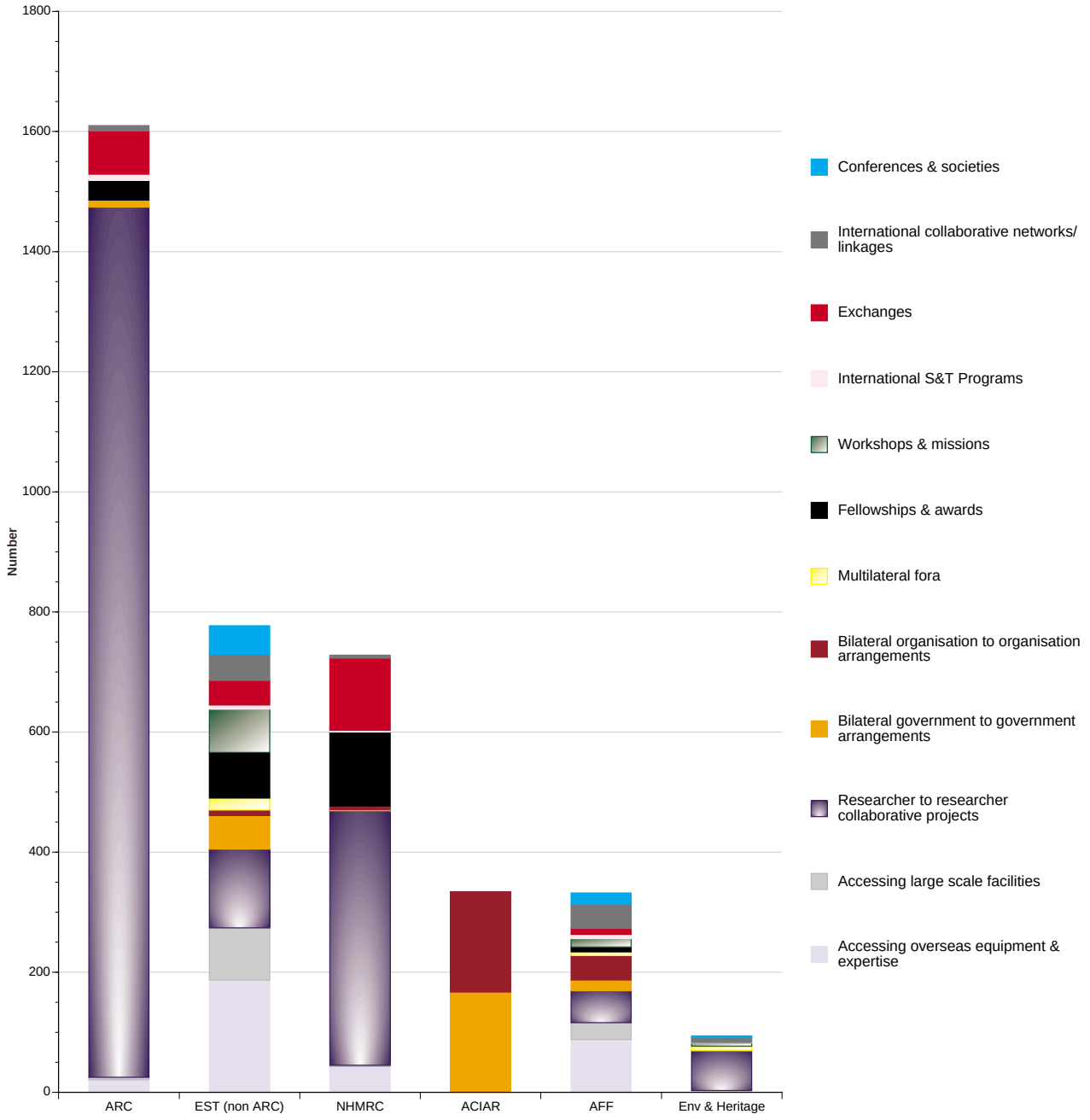
For example, in the case of EST, funding for Access the Major Research Facilities (AMRFs) is specifically aimed at facilitating access to overseas equipment, expertise and large-scale facilities, whereas, IAP–IST Strategic Policy is concerned with bilateral and multilateral agreements and Australia's participation in multilateral fora.

The purpose and type of ACIAR's international S&T activities is split evenly between two types of bilateral arrangements. Bilateral arrangements feature to a lesser extent in the S&T activities of EST and AFF. The Environment and Heritage Portfolio has a high proportion of 'researcher to researcher collaborative projects', which is primarily due to the activities of the Australian Antarctic Division.

Fellowships and exchanges were characterised most easily for EST and the NHMRC, and this is apparent in Figure 3.10.

Figure 3.10

INTERNATIONAL S&T ACTIVITIES – PURPOSE & TYPE BY PORTFOLIO AND AGENCY



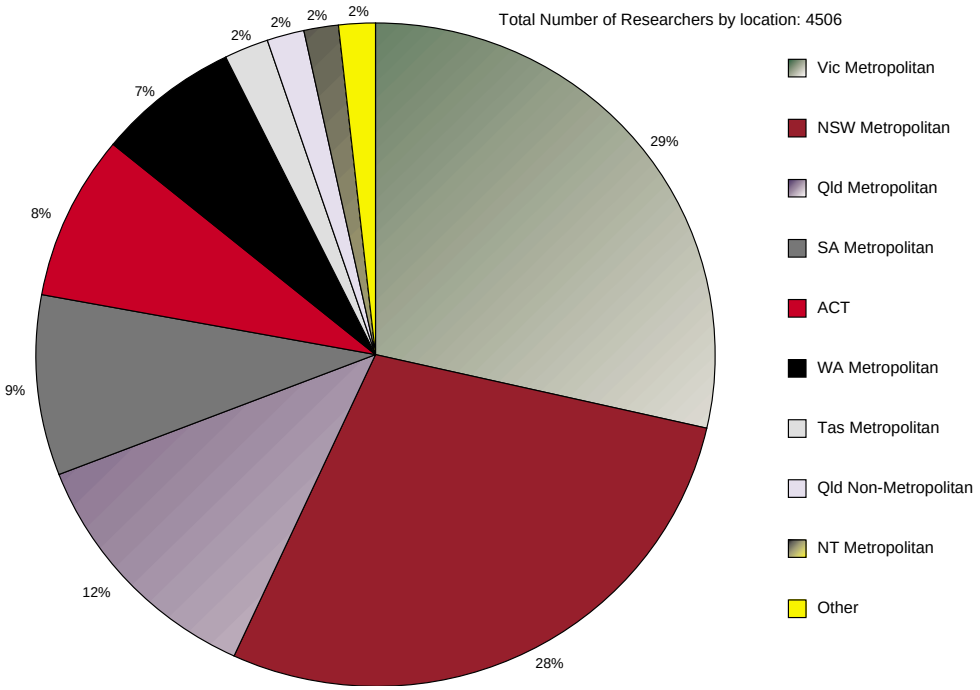
Source: The Allen Consulting Group
Notes: 1. AFF is the Agriculture, Fisheries and Forestry Portfolio including the Research and Development Companies and Corporations.
2. EST is the Education Science and Training Portfolio excluding the ARC, which is show separately.

Geographic Location of Researchers based in Australia – All Commonwealth

Figures 3.11 and 3.12 illustrate that most of the Australian researchers involved in international S&T are concentrated in metropolitan centres in Australia. Identifying the geographic location of researchers is limited by the data, which typically gives the grant recipient location as the home university (usually located in metropolitan centres) rather than the location of the researchers involved.

Figure 3.11

ALL COMMONWEALTH – RESEARCHERS BY GEOGRAPHIC LOCATION



Source: The Allen Consulting Group
Notes: 1. SA Non-Metropolitan and NT Non-Metropolitan regions recorded zero
2. **Other**: NSW Non Metropolitan, Vic Non-Metropolitan, WA Non-Metropolitan, Tas Non-Metropolitan

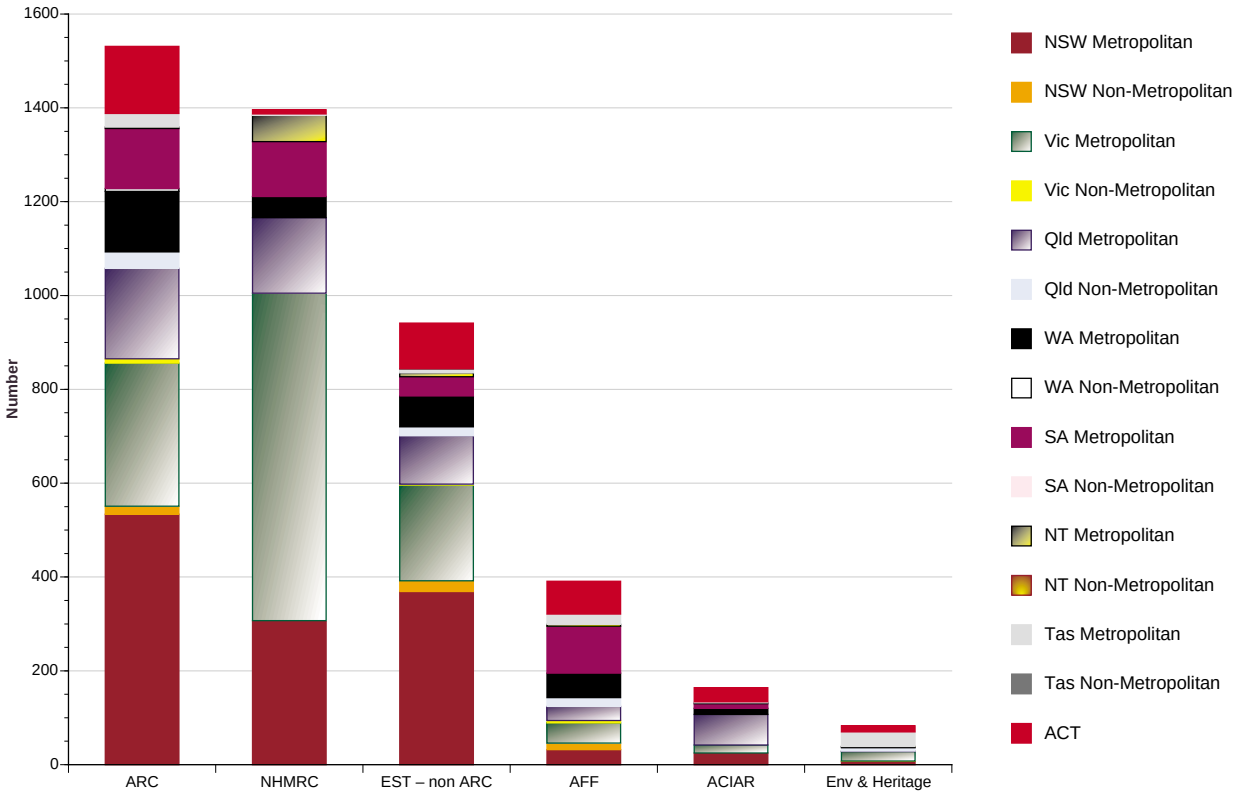
Where information was available from funding agencies, a split between metropolitan and non-metropolitan regions has been included in this analysis. Given that not all collaborations could be characterised by geographic location of researchers in Australia, the findings presented should be interpreted to represent minimum estimates, especially for the non-metropolitan category.

As expected, researchers are concentrated in metropolitan centres of NSW and Victoria with very few researchers located in NT and Tasmania (see Figure 3.11). Marine research is concentrated in Northern Queensland and the research undertaken by the Antarctic Division of Environment and Heritage is concentrated in Tasmania.

Figure 3.12 illustrates that, in relation to international S&T activities, the majority of NHMRC-funded researchers are concentrated in Victoria while the majority of ARC grants are concentrated in NSW. The other Portfolios have a wide range of geographic location of researchers included in their S&T activities, with differing regional concentrations of researchers.

Figure 3.12

INTERNATIONAL S&T ACTIVITIES – GEOGRAPHIC LOCATION OF RESEARCHERS BY PORTFOLIO AND AGENCY



Source: The Allen Consulting Group
Notes: 1. AFF is the Agriculture, Fisheries and Forestry Portfolio including the Research and Development Companies and Corporations.
2. EST is the Education Science and Training Portfolio excluding the ARC, which is show separately.

Concluding Observations

This Chapter has presented an overview of this first analysis of Commonwealth support for international S&T collaboration. The expenditure of $211m identified in 2001-2, underestimates the full amount of spending in this area.

Many of the outcomes from this analysis are in line with expectations. Traditional alliances are observed in regard to the dominance of the US and the UK in international S&T collaboration. Additionally, the research fields in which in the majority of collaborations were conducted are in line with traditional areas of Australia's scientific expertise and economic advantage — namely, Biological Sciences and Agricultural, Veterinary and Environmental Sciences, and Physical Sciences. The majority of international S&T activities involved researcher-to-researcher collaboration and were allocated by research-performing agencies, via peer-reviewed research grants.

The pattern of international S&T expenditure by ACIAR demonstrates how different rationales for international S&T cooperation can result in different emphases, in this case facilitating engagement with neighbouring countries.

While a great deal has been revealed by this analysis, there are many opportunities for improving future studies of Australian international S&T. The present availability of data on the extent and nature of international S&T activities is limited, mainly due to the lack of a coordinated effort in measuring and reporting such activities. In addition, longitudinal data-sets are necessary to assess how well the Commonwealth performs when meeting demand and capturing opportunities in relation to international S&T. However, if these issues are addressed, the basis for future policy decisions will be much improved.

Chapter Four

European International S&T Linkages and Research Priorities

Australia's links with Europe are longstanding. Historically these have been in the areas of natural history, agronomy, marine activities and astronomy. Up to World War II the strongest links were with the United Kingdom, with relatively little linkage with the rest of Europe. Since that time, and with the expansion of S&T in Australia, links have been developed with many European countries on the basis of informal links and bilateral agreements. This trend has accelerated over the past 30 years and collaboration has been established between universities and government research institutes in a number of fields.

The governments of Australia and European countries have sought to promote collaboration and interaction by placing S&T attachés or counsellors in each other's countries. These attachés act as focal points and disseminate information, build bridges and assist visiting researchers. In some embassies, this task is assigned to economic or trade attachés but the most successful are dedicated S&T attachés. Excellent examples of these in Australia are the French and Italian S&T attachés who have built strong national networks in a variety of disciplines. Australia had a reasonable representation in Europe several years ago with coverage of national and international S&T linkages through London, Brussels, Bonn and Paris but this has now been greatly reduced. Such attachés represent a strong symbol of commitment to international cooperation by the Australian Government, which is now lacking in Europe.

Since the development of the EU, its influence on S&T in Europe has grown rapidly, with a recent commitment to the development of a European Research Area and the increasingly focused Framework Programmes. Further, the recent enlargement of the EU has brought another 10 countries into their system. A number of these have S&T capabilities which can be readily integrated, but others need support. While national programs still represent the bulk of S&T activity in Europe, it is likely that European countries will increasingly tend to work between themselves. The proposal for development of Networks of Excellence in the latest Framework Programme will strengthen this tendency. Already, the term 'international' is only being used in Europe to designate activities outside the EU. Australia needs to be aware of the rapidly changing situation in Europe and the potential for loss of interest in Australian S&T, particularly if it is perceived to be declining in quality and output.

A strong point in favour of S&T collaboration with Australia by Europeans is that Australia is perceived as a stable English-speaking multicultural community with a strong scientific reputation in a number of areas (for example, ecology and environmental science, geoscience, plant and animal science, clinical medicine and biotechnology)[12]. Australia also offers opportunities to study issues and problems that are not available in Europe (for example in areas such environment, marine activities and astronomy). Further, it offers a gateway to Asian S&T through Australia's links with the region. Any weakening in these areas reduces Australia's attractiveness as a potential research partner.

[12] FEAST

4.1 International S&T in Europe

A major study[13] of the policies of western European countries on international Research, Technological Development (RTD) and Demonstration cooperation was completed in 1999. Known as the INCOPOL report, this provided a systematic assessment of the policies of these countries in relation to cooperation with each other and with countries outside Europe. The INCOPOL report is the outcome of a one-year research project synthesising seven studies — one addressing each of six regions of the world and one addressing international organisations.

The INCOPOL consultants found that systematic information on national RTD cooperation programs and policies of EU countries does not exist. Published and Internet information provided no quantitative data on the scale of cooperation activities. The problems of data quality (which are the same as those faced in this study) were summarised as follows.

- *Competence and level* — The aim was to investigate government and research council funding. However, the INCOPOL consultants found that many activities take place at lower levels and are not easily captured.
- *Separating the technology component of aid* — Distinguishing S&T investment from technology transfer in an aid context was found to be difficult.
- *Disaggregation* — Some institutions have difficulty in separating the S&T component from their general research budget.
- *Multi-country projects* — Several countries may be involved in a single project or program. This can lead to double counting as well as difficulties of assigning components of the budget to individual countries.
- *Availability of data* — Expenditure data was often not available, or was not available with the level of detail necessary for analysis.
- *Reliability of data* — Data was obtained from different sources, or estimated by different methods. Not all data was of equal reliability.

The INCOPOL study concluded that the vast majority of scientific cooperation is through bilateral cooperation between individual research institutes and bottom-up cooperation arranged by individual laboratories, universities, or researchers themselves. The study did not cover these initiatives but focussed instead at the national policy level, on budgets and programs to provide a picture of targeted policy initiatives.

The major conclusions of the INCOPOL study are set out below.

- Funding agency budgets do not identify the more mature or advanced cooperation activities in S&T. Their expenditures support relations which are promoted for policy reasons and often implemented through other agencies. In those areas, and between those countries where bottom-up links are sufficiently developed, government expenditure on RTD cooperation activities tends to be low. RTD agreements and scientific attachés provide a facilitating framework for many bottom-up cooperation activities, where each party brings its own budget, normally from operating funds. In this context, joint publications from authors of different national backgrounds are a better measure than expenditure.

[13] Rhode, B and Stein J A (Eds), 1999, *International Cooperation Policies of the EU/EEA Countries in Science and Technology (INCOPOL)*, Synthesis report prepared for CREST and the European Commission.

- Motives which drive RTD cooperation include:
  - historical and cultural links;
  - access to knowledge and expertise;
  - testing of hypotheses in specific situations;
  - access to markets and trade reasons;
  - recipient country development; and
  - developing networks for future cooperation.

- The motivation for international S&T links with countries outside Europe is mainly related to traditional cultural and colonial links and account for the highest amounts of expenditure. The biggest international S&T budgets related to aid or technical assistance. Traditional cultural links are much stronger than trade relations or any other market aspects.

- Total spending on external bilateral RTD cooperation by the 18 EU and European Economic Area (EAA) countries[14] has been estimated by the INCOPOL team at around 750 MECU[15] per year in 1996. Large parts of this expenditure are not necessarily spent in or for the countries concerned, but on national scientists and their work for the development of third partners. Approximately 20 per cent of this funding is devoted to international programmes mainly towards the developing countries with no specific regional focus. Nearly 25 per cent is spent on RTD cooperation and capacity building in Africa. The non-EU Mediterranean countries, Latin America, Asia and the newly independent states of the former Soviet Union receive around 10 per cent each, the Central Europe and Baltic States about 12 per cent.

- None of the EU/EEA countries display a coherent S&T cooperation strategy or policy. The involvement of different funding agencies leads in general to more unstructured and fragmented policies. More centralised countries (France, the Netherlands and Finland) are able to carry out more structured implementation policies. The Nordic countries generally concentrate their S&T cooperation effort on aid, mainly in training and mobility schemes. France, the UK, the Netherlands and the Nordic countries tend to spend more on joint research projects and invest in direct scientific cooperation.

- Amongst the 18 EU/EEA countries, France invests the most in international S&T cooperation (with a focus on French speaking African countries), mainly aid-related. France also has the most extensive science attachés network in the highly industrialised countries (US; Japan; Korea; Canada; Australia; and New Zealand). Germany seems to be the biggest spender on Central and Eastern Europe and by far the biggest spender on Russia. Countries with a generally low national budget for RTD spend very little on international cooperation.

In relation to S&T cooperation with highly industrialised countries, INCOPOL found the following.

[14] EEA countries comprise the 15 EU Member States and the three EFTA countries: Iceland, Liechtenstein and Norway.

[15] The European Currency Unit (ECU) is the Euro (€). At the exchange rate applying in May 2003 (€ 1.0 = $A1.81) this is equivalent to $A1.36b. Adjusting for inflation and subsequent increases in European international S&T activity would suggest a current level of expenditure in excess of $1.5b.

- Most international S&T collaboration is planned and executed by the same bodies that are responsible for the corresponding areas of national policy or activity. Some highly industrialised countries have a central co-ordinating body for collaboration, but, compared to the infrastructure supporting S&T cooperation within Europe, the structures to support other international S&T are very modest.

- Individual ministries and intermediary bodies such as research councils manage their own international S&T cooperation.

- The distribution of EU/EEA science attachés shows a strong presence in the US and Japan. France has by far the largest number of science diplomats in all, followed by Germany, Sweden and the UK. Outside this group, Italy maintains a wide science diplomat network.

- There are few S&T areas that do not feature as priorities in cooperation with the larger highly industrialised countries. Paradoxically, this reflects a lack of prioritisation arising from the decentralised nature of much collaborative activity. Information technologies and industrial technologies feature strongly with the larger countries, while agriculture and fisheries are reported to be more important with Australia and New Zealand. Biotechnology is the only topic to emerge as a priority in all cases.

In relation to trends in European cooperation with the highly industrialised countries outside Europe, INCOPOL concluded that in the period 1985 to 1995, the pattern of co-authored publications showed dramatic changes. Collaboration with the US almost doubled to nearly 10 per cent of EU/EEA publications, fairly evenly spread across Europe. Increases also took place with other highly industrialised countries, with Canada remaining the second most frequent collaborator over the decade. The biggest proportionate change is for co-authorship with the Asian countries, with Japan moving well ahead of Australia at 1.33 per cent of EU/EEA papers. Korea increased co-authorship by an order of magnitude but remains at a relatively low level.

The study classified scientific agreements with the highly industrialised countries outside Europe into three groups.

- Governmental activities (nuclear, space, defence) where the agreement gives a formal basis to actions by government employees.

- Frameworks for less formal collaboration which offer ready-made formulae on matters such as intellectual property rights, typified by the growing tendency towards umbrella agreements.

- Symbolic agreements, made to demonstrate good relations.

Cooperation with the US is a priority for all European countries. The US is the only country where European cooperation budgets of any significant size are identified, largely because of the importance of space and nuclear research. This marks a separation between larger and smaller highly industrialised countries, with the latter co-operating largely through multilateral agencies in these fields, while the former regard it as necessary to maintain bilateral linkages.

Within Europe, the collaborative R&D project is the dominant form of cooperation. The situation is reversed for cooperation with the non-European highly industrialised countries, where mobility and informal contact (often also involving travel) are by far the most important.

Many EU/EEA countries have historically based links, particularly with the US, through expatriate communities or defence cooperation. Bottom-up linkages are particularly likely to reflect historical, linguistic, cultural and personal linkages within research.

'Big Science' cooperation is now an important element of European international S&T cooperation. For governments it offers the opportunity to share costs with little loss of prestige, while for scientists there is some assurance that access to leading edge facilities will be assured as governments become 'locked in' to the relevant international arrangements.

INCOPOL sees future trends as follows.

- The strongest trend has been a growing emphasis on the significance of science in relation to national competitiveness. This has been combined with a tendency towards prioritisation. Growing interest in collaboration in areas of industrial significance has resulted in concerns about intellectual property. The same trends have produced a new impetus for collaboration driven by the desire to work with the best partners in the world.
- The ease of electronic communication is already transforming global collaboration and enabling scientific teams to emulate industry in round-the-clock working, and these trends are expected to continue.
- Access to large scientific instruments as a justification for international S&T may become less significant, mainly as a consequence of growth in other areas of S&T cooperation.
- In terms of likely trends in priority countries, Japan and Korea are likely to attract greater amounts of interest from EU/EEA scientists. Globalisation of industry is itself a likely vector for collaboration with these and other highly industrialised countries.

In general terms, the benefits of collaboration may be seen as falling into two main categories:

- Direct benefits to the S&T concerned, allowing the research to be performed and/or applied at a higher quality, with a broader scope, more quickly or more economically than would be the case without cooperation.
- Indirect benefits arising from the existence of the cooperation. These may accrue directly to the participants (for example, through enhancement of reputation, access to further research funds) or more generally to the countries involved in terms of political, economic or social benefits.

The principal motivation for cooperation among highly industrialised countries is to enhance scientific or technological excellence. Cooperation may also stem from the desire to perform research on, for example, a natural phenomenon present in one of the countries (such as the southern skies which are visible to Australian astronomers), or where one country is the 'host' to a large, expensive scientific instrument.

Issues that are of concern to more than one country (for example, global warming) are another major area of international S&T cooperation. International S&T collaboration is also driven by external goals of a political, economic or cultural nature.

Highly industrialised countries seek to align international S&T cooperation with domestic priorities. With many countries trying to focus their national research systems, it is not surprising that there is a similar desire to apply this logic to collaboration. However, the historical legacy of collaboration, and persistent cost-sharing imperatives, keep the balance of activity in Big Science areas that are not necessarily domestic priorities. Newer collaborations tend to address the familiar themes of IT, biomedicine, environment and new materials.

4.2 European Union – The Key Player

Framework Programmes

The EU has endeavoured to build a European approach to S&T as a policy initiative to match other policies such as agriculture, trade etc. The main instrument for this has been the Framework Programme for actions in the field of research and technological development; it defines the objectives, priorities and financial support from the EU for a period of approximately five years. This is designed to enable effective medium to long term planning of research.

The First Framework Programme (1984-7) was followed by the Second (1987-91), the Third (1990-4), the Fourth (1994-8) and the Fifth (1998-2002). The latest Sixth Programme was launched in November 2002 with specific objectives of 'Integrating and Strengthening the European Research Area' and 'Structuring the European Research Area'.

Australian involvement in the Framework Programmes dates from February 1994 when it was the first non-European industrialised country to sign an agreement of accession to the Programme. This agreement allowed Australian researchers to participate in activities of the Fourth Framework Programme of European Research (1994-8) in six fields: biotechnology, medicine and health, marine S&T, environment and information and communication technologies. The EU did not, however, fund the participation of Australian researchers and Australians had to seek local funding which was limited.

The agreement was renegotiated in July 1999, during the Fifth Framework Programme, to allow Australian researchers full participation in all fields of research covered by the Programme with limited access to European funding. Conversely, European researchers were given the possibility to participate in all Australian S&T activities. As Table 4.1 shows, while the number of Australian researchers involved has not changed significantly, there has been a major increase in the size of projects involving Australian researchers between the Fourth and Fifth Framework Programmes.

The most active project areas are medical and health research, information technologies and environment, which account for roughly two thirds of the total. It is important to recognise that, while Australians are involved as contractors or sub-contractors to EU consortia, they represent significant added value both for the financing and research aspects of the projects.

Table 4.1

STATE OF EU-AUSTRALIA COOPERATION

	Framework Program 4 1994-8	*Framework Program 5 1998-2002*
No. projects as a full contractor	30	33
No. projects as a subcontractor	4	5
No. projects as an assistant contractor	0	1
No. of Australian researchers	48	44
Value	$A72m	$A310m
Value of other collaborators	$A97m	$A144m

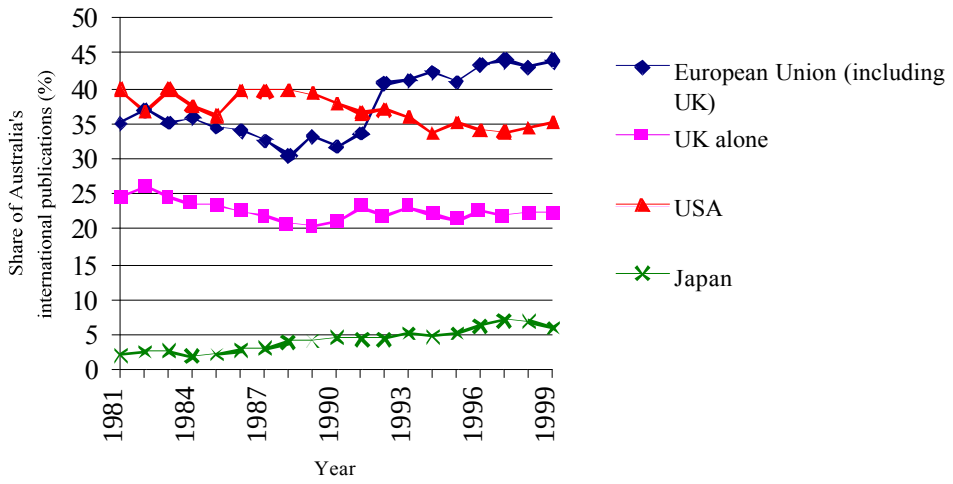
Source: EC Delegation (Canberra)

The increasing importance of collaboration between Australia and European researchers is reflected in the statistics of publications involving international collaboration. As shown in Figure 4.1 there was a dramatic increase in the share of publications involving European researchers over the 1990s so that by 1999 the EU accounted for 45 per cent of all Australian articles involving international collaborators (up from 37 per cent in 1981).

Within the EU the UK has been the major partner, but it declined in relative importance from 21 per cent in 1981 to 17 per cent in 1999. Germany (9 per cent in 1999) was the second most important partner followed by France (6 per cent), the Netherlands and Sweden (4 per cent) and Italy (3 per cent). Data are not available for the period since 1999 but it appears that the changing pattern is being continued, as evidenced by increased numbers of projects with France and Italy. It should be noted that there is no simple explanation for the increase in EU publications between 1991 and 1992 in Figure 4.1.

Figure 4.1

SHARE OF AUSTRALIA'S INTERNATIONAL PUBLICATIONS (1981- 1999)



Source: Sara, V, 2001, *Strengths of the European –Australian Research Relationship from the Australian perspective*, Paper presented to the FEAST, May 2001 sourced from Butler, L (private communication)

There appear to be five main categories of benefits motivating participation by Australian researchers in EU projects.

- Strategic contribution to creation of critical mass in leading edge research projects.
- Access to new technology and to the European market.
- Managerial access to expertise, new systems, new fields of research.
- Technical access to new practices, models and databases.
- Personal rewards in terms of status, growth of knowledge, membership of networks.

The European Commission launched the Sixth Framework Programme in November 2002 with a budget equivalent to $A29 billion over 4 years (2002-6). This is the core instrument for driving the creation of the European Research Area and has seven thematic priorities with emphasis on SME participation. Concurrently the Australian Government identified four National Research Priorities in December 2002. These two sets of priorities can be mapped onto one another, as shown in Table 4.2. Each of these priorities has a detailed list of sub-themes, which have many common elements for the EU and Australia.

Table 4.2

COMPARISON OF EU AND AUSTRALIAN PRIORITY AREAS

EUROPE	Life Sciences, Genomics & Biotechnology for health	Food Quality & Safety	Nanotechnologies & nanosciences, knowledge based multifunctional materials & new production processes & devices	Information Society Technologies (IST)	Aeronautics & Space	Sustainable Development	Citizens & governance in a knowledge based society
AUSTRALIA	Promoting and Maintaining Good Health		Frontier Technologies for Building and Transforming Australian Industries			An Environmentally Sustainable Australia	Safeguarding Australia

Source: FEAST

Improved international competitiveness and quality of life are the shared goals of the European and Australian Governments in their selection of priority areas. There are a number of commonalities that present opportunities for increased collaboration in research development and training between Europe and Australia. These include:

- health, in particular, disease and the ageing population;
- sustainable development, including climate change, biodiversity, land and water management;
- emerging technologies, such as biotechnology and nanotechnology; and
- ICT solutions for business.

Under certain conditions it is possible for EU funding to be provided to support the Australian input to a European consortium and this may stimulate further collaboration. There are also increased opportunities for research training under a range of new schemes and this should stimulate the building of networks between young researchers.

The development of Networks of Excellence in Europe as a feature of the new Framework Programme, coupled with the ARC's recent Research Networks initiative can only tighten the linkages in discipline areas and speed up the flow of information about R&D capabilities in each region. As the profiles in Table 4.6 show, there is a dearth of information on a number of countries in Europe.

Forum for European and Australian S&T Cooperation

In November 2000 the group of scientific attachés of the EU embassies in Canberra, together with the Scientific Advisor of the EC Delegation for Australia and New Zealand, with the support of the then Department of Science, Industry and Resources, founded the Forum for European and Australian Science and Technology Cooperation (FEAST) to provide a dedicated European-Australian group to organise events encouraging S&T cooperation. FEAST has two main objectives:

- to increase bilateral and multilateral S&T cooperation between Australia and European countries; and
- to support the on-going cooperation.

FEAST aims to achieve these objectives through its website and database, and the organisation of conferences and workshops around Australia. Three FEAST Conferences have been held since 2001, with the fourth conference planned for November 2003 in Canberra.

The FEAST concept has been strongly supported by France and Italy through the development of State networks, websites and publications highlighting bilateral collaboration. FEAST-France has formed groups (Australians with French links and visiting French researchers) in several States (ACT, Victoria, NSW and Queensland) with liaison officers in research institutions in each State. These groups are building interest groups and acting as contact points for liaison officers from institutions in France with particularly strong linkages (for example, La Rochelle, Toulouse and Reims).

Similarly, groups of researchers with Italian connections (both Australians and Italian visitors) have been formed as non-profit associations in several States (ACT, Victoria, Western Australia and New South Wales). Again, these associations are building interest groups, organising linkages and providing contact points for Italian institutions. A very successful Italian-Australian Technological Innovations Conference and Exhibition was held in Melbourne in March 2002.

Such initiatives allow access to a wider range of S&T literature published in French and Italian. Material in other European languages is less readily accessed (for example, details of national Foresight and priority-setting exercises or innovation initiatives).

4.3 Other Multilateral European Cooperation in S&T

For most European countries, the major foci of their international S&T are the EU Framework Programs, EUREKA and the activities of COST.[16] Other significant European S&T cooperation takes place through CERN,[17] the European Synchrotron

[16] COST is the abbreviation for Coopération européenne dans le domaine de la recherche scientifique et technique (European cooperation in scientific and technological research).

[17] CERN is a French acronym - Centre European pour la Récherche Nucléare (European Laboratory for Particle Physics)

Radiation Facility (ESRF), the European Molecular Biology Organisation (EMBO) and the European Space Agency (ESA).

Most of the cost of participation in the EU Framework Programs is met from the EU budget. EUREKA and COST activities are fully financed from national budgets. The other organisations listed are supported through contributions from member states.

COST

COST is a framework for research cooperation between European countries. There are currently about 150 activities in 20 research fields. Each lasts an average of 3 to 4 years. Cooperation is initiated by groups of researchers. COST member countries may choose to participate in Actions depending on their national research priorities. In June 2002, COST included 35 Member States. COST has a flexible structure that allows participants from non-member countries, including Australia on a case-by-case basis by invitation.

EUREKA

EUREKA is a pan-European network for market–oriented, industrial R&D through international collaboration. The objective is to bring high quality R&D efforts to the market and to use the multiplying effects of cooperation

EUREKA was established in 1985 to encourage technological development and to strengthen the competitive position of European companies on the world market.

EUREKA's organisational structure is composed of four main bodies.

- The annual Ministerial Conference, which is the political body of EUREKA. The Ministerial Conference announces the new projects endorsed during the year. Ministers also take decisions on the further development of EUREKA.
- The High Level Group, which meets three or four times a year and takes decisions on the management of EUREKA.
- National Project Coordinators, who are responsible for contacts with project participants and potential project participants in each member country.
- The EUREKA Secretariat in Brussels, which is the central support unit for EUREKA.

Thus European countries have many opportunities for international S&T across a wide range of fields of science.

4.4 Individual EU Countries

As noted earlier, overall European S&T priorities have been set out in the Sixth Framework Programme. However, given that more than 90 per cent of total S&T funding in Europe is still in national systems, countries have sought to identify their own national niches within the broader general areas.

All current, and nearly all the new members, have carried out Foresight exercises in various forms to help identify their strengths and weaknesses, and to identify emerging technology areas. The Institute for Prospective Technological Studies, a unit of the EC Joint Research Centre, has carried out a number of comparative analyses of these studies and there is now a unit in Brussels translating Foresight results into policy (for example, influencing the Sixth Framework Programme). This literature on Foresight in Europe needs more study by Australian researchers and policy makers to gain a better picture of future trends in Europe.

Relative Activity in Collaboration with Australia

One measure of the relative activity in collaboration with Australia is the number of co-authored publications as noted earlier in this Chapter. Other measures of relative activity include the distribution of ARC funding for international collaborative projects and the number of CSIRO collaborative projects with individual countries Data on these two measures were collected for FEAST in 2002 although the absolute values need to be treated with caution due to unreliability of source data. Table 4.3 summarises the results.

Table 4.3

PATTERNS OF COLLABORATION WITH EUROPE IN 2001

COUNTRY	*ARC FUNDING FOR* COLLABORATIVE PROJECTS (%)	*CSIRO COLLABORATIVE* PROJECTS (%)
AUSTRIA	1.6	3.1
BELGIUM	2.3	1.7
DENMARK	3.1	1.7
FINLAND	1.1	3.1
FRANCE	15.8	14.1
GERMANY	20.1	19.2
GREECE	0.6	0.7
IRELAND	0.8	1.0
ITALY	5.9	9.3
NETHERLANDS	5.8	9.3
PORTUGAL	0.2	0.7
SPAIN	3.1	0.7
SWEDEN	5.8	4.1
U K	32.8	24.7
NORWAY	-	3.1
SWITZERLAND	-	3.4

Source: Johnston, R, 2002, Collection and Analysis of Data on *Australian-European S&T Collaboration Report* to FEAST November 2002.

It is clear that the main players are UK, Germany, France, Italy, Netherlands and Sweden. Links with the other EU countries namely Austria, Belgium, Denmark, Finland, Ireland, Greece, Luxembourg, Portugal and Spain are much weaker if they exist at all. This is not surprising given that these are either small countries with limited resources or, in some cases, countries coming from a weak S&T base with the help of EU funding. Countries in these two categories are focused on Europe and have no ambitions for S&T cooperation with Australia even though some have trade and investment links.

This pattern is repeated in data from the FEAST database, which shows the country with which a Registered Researcher identifies. Table 4.4 gives the latest pattern and shows the number of researchers from EU countries that have registered themselves on the database as a researcher. Each may be a current or a potential research collaborator. The figures in Table 4.4 are indicative only, and are therefore a weaker indicator of research links since many active researchers are not registered on the database. The large number of researchers with French links reflects the strong network of FEAST-France.

In comparison to the numbers of EU registered researchers, the number of Australians registered is 1161 reflecting the strong interest of Australian researchers in possible links to Europe.

Table 4.4

REGISTERED RESEARCHERS FROM EU COUNTRIES (FEAST)

Country		Country	
Austria	10	*Ireland*	11
Belgium	16	*Italy*	43
Denmark	8	*Netherlands*	20
Finland	12	*Portugal*	9
France	411	*Spain*	36
Germany	81	*Sweden*	21
Greece	1	*United Kingdom*	87

Source: FEAST

4.5 EU Countries' International S&T Programs

Because of the very strong EU programs to promote cooperation in S&T within Europe, individual member countries international S&T efforts are also strongly focussed on cooperation within Europe. International programs with countries outside Europe are of lesser importance for most EU countries. However, as noted above some EU countries, particularly the larger ones, have their own international S&T programs in order to facilitate co-operation with the rest of the world.

In reviewing EU country programs that support international S&T, this study has limited its analysis to those countries that have significant relevant programs providing significant levels of support for S&T co-operation *outside Europe*. The results are summarised in Table 4.5. This table illustrates that, although the principal source of funding is the government in each case, the agencies involved in program management can be research councils, central research organisations or academies.

Most European countries have mechanisms to support participation in the development of new major international research projects including those within the EU's Framework program. Most also have fast response mechanisms in order to be able to take advantage of opportunities as and when they arise. The smaller countries support the hosting of scientific conferences as a means of building international linkages.

4.6 EU Country Profiles

A profile of each EU country has been constructed based on published material and on material from the Internet together with discussions with some Embassy representatives in Canberra. Internet searches have focussed on S&T policies and innovation on national websites. Useful information was obtained from EU Web sites particularly those prepared for each Presidency of the EU (countries hold the Presidency for six months on a rotating basis). Recent Presidents have been from Spain and Greece. The Organisation for Economic Co-operation and Development (OECD) has also been a valuable source, particularly the Science, Technology and Industry Scoreboard 2001 and the Science, Technology and Industry Outlook 2002.

In a number of countries where formal links with Australia in S&T do not exist it is difficult to get details of existing collaborations since much of it is researcher-to-researcher or institution-to-institution activity. Information on some countries is difficult to access since it is available only in the national language. Opportunities for collaboration were identified by matching research strengths of countries with Australian strengths.

Table 4.6 provides a summary of the EU profiles as well as examples of existing collaborations identified through the international S&T mapping exercise undertaken for this study. Further details and examples are included in Chapter 8 and the Appendices to this study. Note that Luxembourg is not included as there are no data available.

In Table 4.6 levels of current S&T collaboration and the opportunities for future collaboration with individual countries have been assessed as 'high', 'medium' or 'low' taking into account the other factors in the table and the preceding discussion.

4.7 Comments on the Country Profiles

A number of conclusions emerge from the country profiles.

The limited number of strong collaborators — the profiles reinforce the earlier discussion that the main collaborations are with the larger European countries and those with strong scientific traditions, namely UK, Germany, France, Italy, Netherlands and Sweden. These generally have well-funded international co-operation programmes backed up with worldwide networks of scientific attachés. Only two of them, namely France and Italy, have scientific attachés in Australia and their activities are reflected in increasing co-operation. This pattern seems set to continue and possible areas for collaboration are constantly being explored.

Table 4.5

EU COUNTRIES, INTERNATIONAL S&T PROGRAMS

France	*Germany*	*United Kingdom*	*Ireland*	*Finland*
The Centre National de la Recherche Scientifique (CNRS) (The National Centre for Scientific Research) has a budget in excess of $A4b and is the major body responsible for supporting research in France. The CNRS has 5,000 foreign trainee placements in the laboratories, 81 exchange agreements with over 50 countries, 180 international programmes involving scientific cooperation, and 35 associated European laboratories and twinning agreements. In addition to other French science diplomatic staff, the CNRS has staff posted to 10 overseas countries. The CNRS provides funding for international activities much of which is country specific. Applications are generally sought twice per year. Other French Government agencies provide support for international science cooperation in their areas of responsibility.	The Deutche Forschungs-gemeinschaft (DFG) (The German Research Foundation) encourages international cooperation between individual scientists, projects, programs, and measures to prepare for collaborative projects. Research grants can be used to fund staff, scientific instrumentation, consumables and travel. Through its various programs, the DFG provides funding for joint projects carried out with international partners and the integration of international groups into various research networks. The DFG also provides bilateral support for research projects, project preparation, bilateral symposia and seminars, preparatory trips and cooperation visits. The DFG has agreements with more than 50 partner organisations in Europe and overseas. Special programs provide support for early career researchers. The Alexander von Humboldt Foundation promotes international research cooperation. It funds foreign scholars to visit Germany and promotes subsequent contacts.	The Office of Science and Technology's International Directorate manages UK involvement in the European Union's S&T activities and seeks to develop and strengthen bilateral and multilateral links with major scientific partners across the world. An international co-ordination committee is chaired by the Government's Chief Scientific Adviser. The UK has a wide range of programs that support research links with countries outside Europe, including travel grants, research fellowships, and joint research projects. Some are directed to particular countries or regions, some are focused on particular areas of science and technology, while others support particular kinds of research links, such as post-doctoral fellowships. Support for international S&T is also available from the seven Research Councils, the Royal Society and The British Council. Other government agencies support international S&T relevant to their missions.	The major focus of Irish international S&T activities is the EU Framework Program. However Ireland has bilateral cooperation with several countries, including China. The Science Foundation of Ireland (SFI) provides grants for researchers from around the world to undertake research in Ireland. The SFI also supports workshops and conferences sponsored by or involving Irish scientists and research bodies and aimed at an international scientific audience. These workshops and conferences aim to connect the research and industrial communities and attract grants up to €50,000 ($A90,500).	The Academy of Finland supports researchers' work and studies abroad with the aim of upgrading the quality of research and to increasing researchers' international mobility. The Academy funds international S&T cooperation through support for research projects, research programs and its centre of excellence program. Bilateral researcher exchange is also supported. The Academy funds travel to meetings preparing projects and applications for international research projects. Up to $A72,000 is available to coordinators and participants for costs incurred in these preparations including preparation of expressions of interest. The Academy supports up to 30% of the costs of international scientific conferences in Finland. Priority is given to recurring conferences of international scientific organisations. Assistance covers travel and accommodation costs of invited foreign lecturers, venue and secretarial expenses.

Source: The Allen Consulting Group

Table 4.6

INTERNATIONAL SCIENCE AND TECHNOLOGY LINKAGES

	AUSTRIA	BELGIUM	FINLAND	PORTUGAL	SPAIN
Research priorities	• Biotechnology - genome research • ICT - e-based economy • Advanced manufacturing • Aeronautics and space	• Knowledge economy - e-business and e-learning • Biotechnology	• Biotechnology • Pharmaceuticals • IT and electronics • Knowledge society • Innovation in SMEs	• Build knowledge society • Strengthen skills base	• Biotechnology • Transport industry - vehicles, aircraft • Environment and Knowledge society • Co-operation with Latin-American countries
Existing collaboration	Limited - light metals, biology.	Not known.	Industrial links in pulp, paper & minerals processing, IT, post-grad student exchange.	Not known	Not known.
Opportunities for collaboration	Materials technology, research mgmt (Austrian centres are based on CRCs).	Not known.	Not known.	Renewable energy-wind power.	Aquaculture, renewable energy - wind power.
Problems for collaboration	**In Austria** • limited research funding • fragmented S&T policy • weak links of universities to industry • focus of effort on Europe and Russia **In Australia** • limited knowledge of Austrian S&T	**In Belgium** • language and culture divisions national R&D low - mainly industry • Uni research low • low levels of innovation • high communication costs **In Australia** • lack of knowledge of Belgian S&T	**In Finland** • strongly focused on Europe and Russia • highly innovative firms but poor university/ industry links **In Australia** • lack of information on Finnish S&T	**In Portugal** • strong links to Europe - no cultural links to Australia • limited resources of S&T • limited innovation capacity in industry **In Australia** • lack of information on Portuguese S&T	**In Spain** • strong focus on Europe and Sth America • no cultural links to Australia • limited resources - low R&D expenditure • low level of innovation in industry **In Australia** • lack of knowledge of Spanish S&T
Moves to improvement	**In Austria** • new university organisation, more autonomy • new Austrian Council for R&TD • new co-operative research centres (18 in total) • increased funding **In Australia** • none	**In Belgium** • increased funding • reduction of communication costs **In Australia** • none	**In Finland** • program on Advanced Technology Policy • improved funding for innovation **In Australia** • none	**In Portugal** • build technical support to industry • train more people **In Australia** • none	**In Spain** • increase number of young researchers **In Australia** • none
Collaboration with Australia	Low	Low	Low	Very low	Low but potentially useful link to South America

Source: The Allen Consulting Group

Table 4.6 continued

INTERNATIONAL SCIENCE AND TECHNOLOGY LINKAGES

	GERMANY	GREECE	SWEDEN
Research priorities	• E-learning • Biotechnology, genetic engineering, tissue engineering (largest number of new start-up companies in Europe) • Genome research • IT - nanoelectronics, communications, software • Microsystems technology • Training young scientists • Innovation and creation of SMEs	• Food and aquaculture • Culture and tourism • Sea transport • Energy • Earthquake protection • Environment • Health • Knowledge-based economy	• Biotechnology and bioscience • IT and microelectronics • Materials technology • Environment and sustainable development • Health care and social care
Existing collaboration	Extensive but difficult to track industrial links in IT, defence, manufacturing; exchange visits.	Not known - individual researchers.	Limited - post-graduate interchange, geology, Industrial links in defence, manufacturing & IT
Opportunities for collaboration	Nanobiotechnology, proteome analysis, bioinformatics, tissue engineering, genome research, nanotechnology and materials.	Environmental protection, marine research.	Renewable energy - photovoltaics, biofuels and biotechnology.
Problems for collaboration	**In Germany** • complex system of research institutions • lack of young researchers • focus on Europe, Japan and US • lack of Australian S&T attaché **In Australia** • lack of information on German S&T	**In Greece** • low R&D expenditure • lack of innovation in industry • lack of young researchers • strong focus on Europe and enlargement countries **In Australia** • lack of information on Greek S&T	**In Sweden** • strong linkages to Europe, US and Japan • fragmented approach to S&T but high expenditure • low international mobility of researchers **In Australia** • lack of knowledge of Swedish S&T
Moves to improvement	**In Germany** • restructuring of research system to link Federal and Lander structures - 15 new national research centres (Hermann von Helmholtz Association) • reform of university structures - new degrees • increased funding for international experience for young researchers **In Australia** • none	**In Greece** • increased funding for post-graduates • government stimulation of venture capital market • taxation concessions for industry R&D **In Australia** • none	**In Sweden** • restructure of science policy and funding • new agencies created - Innovation Systems (INNOVA) and Swedish Research Council • stimulation of start-up companies **In Australia** • none
Collaboration with Australia	High	Low	Low

Source: The Allen Consulting Group

Table 4.6 continued

INTERNATIONAL SCIENCE AND TECHNOLOGY LINKAGES

	IRELAND	ITALY	NETHERLANDS
Research priorities	• Building a technical base for indigenous development - 8 programs including, biotechnology, optoelectronics, materials, advanced manufacturing technology • Building a knowledge-based society	• Environment and energy • Quality of life • Sustainable development • Mediterranean civilization in the global system (Within these broad areas there are strategic programs and projects which match a number of Australia's priorities)	• Genomics research - bioinformatics, food and health, diseases • Information technology – the "Digital Delta" • Electromagnetic capacity technology • Stimulate innovation in industry
Existing collaboration	Very limited - institutional links e.g. VUT/ Trinity College.	Extensive - ICT, robotics, materials, biotechnology.	Limited - institution/institution e.g. CSIRO/TNO.
Opportunities for collaboration	Unknown.	Nanotechnology, synchrotron technology, biomedical technology, rail technology.	Not known.
Problems for collaboration	**In Ireland** • strong focus on Europe • limited resources for S&T • high-tech industries dominated by multi-nationals • cultural links to Australia but little else **In Australia** • cultural links but no knowledge of Irish S&T	**In Italy** • focus on Europe and Enlargement countries in Mediterranean • low R&D expenditure • lack of young researchers • lack of knowledge of Australian S&T **In Australia** • strong cultural links but lack of knowledge of Italian S&T • complexity of privacy legislation is seen as disincentive, particularly in biomedical area	**In Netherlands** • complex structure of support for R&D e.g. 5 Foresight reports from different groups • need to focus research • lack of young researchers • emphasis on Europe; elsewhere - Japan, US and Singapore • lack of knowledge of Australian S&T **In Australia** • lack of knowledge of Dutch S&T
Moves to improvement	**In Ireland** • increased research funding directed to strategic areas • strong expenditure on education and training **In Australia** • none	**In Italy** • increased expenditure on R&D (to double over 6 years) • strengthen R&D infrastructure • create interdisciplinary Centres of Excellence with public/private partnerships **In Australia** • strong efforts by Italian Embassy to build state networks with Italian community support; also strong publication and workshop program(24 in past 2 years)	**In Netherlands** • reform of system - better co-ordination • moves to increase university/ industry interaction • strategic programs e.g. genomics research with targeted areas **In Australia** • none
Collaboration with Australia	Low	High	Low

Source: The Allen Consulting Group

Table 4.6 continued

INTERNATIONAL SCIENCE AND TECHNOLOGY LINKAGES

	DENMARK	FRANCE	UNITED KINGDOM
Research priorities	• Biotechnology - food processing • Pharmaceuticals • Renewable energy - wind energy	• Environment, energy, sustainable development • Life sciences • Aeronautics and space • Information technology • Transport and Materials • Innovation in industry • Training young researchers	• Genomics • ICT and the knowledge society • Nanotechnology • Biotechnology • Climate change • Food safety and Energy • Genetics
Existing collaboration	Limited - Recombinant DNA technology.	Extensive (approx 140 projects) - agriculture/land management (plant biology, water management) marine (coral reefs, aquaculture, climate) materials and physical chemistry (plasma,colloids) health (nuclear medicine, genomics) information technology. Also strong links in industry (FAIR Program) and defence; Post-graduate student exchange.	Very extensive and strong cultural links - UK second only to US in terms of volume and influence of scientific publications, also shared facilities such as Anglo-Australian Observatory.
Opportunities for collaboration	Renewable energy - wind power.	Strengthening existing areas, nanotechnology, synchrotron technology.	Continue and strengthen existing links - Note that research priorities map closely to Australia.
Problems for collaboration	**In Denmark** • strong focus on Europe • limited resources of funding and researchers **In Australia** • lack of information on Danish S&T	**In France** • strong links to Europe especially with enlargement countries • decline in number of researchers • need for more information on Australian S&T **In Australia** • lack of funding for increased linking • delays in bureaucracy with agreements • need for more information on French S&T	**In UK** • need to improve university/ industry links and increase innovation and SME creation • increasing focus on Europe but also other countries **In Australia** • lack of funding in some areas
Moves to improvement	None	**In France** • increased funds for young researchers to spend periods overseas • increasing networks with French researchers **In Australia** • increasing resources for international links • strong information program by French Embassy - publications and meetings, visits by French experts, rapidly growing networks within research institutions	**In UK** • increased investment in research funds and infrastructure • new Higher Education Innovation Fund to promote exploitation of research through spin-offs • extend network of science attachés **In Australia** • increased funding for S&T
Collaboration with Australia	Low	High	High

Source: The Allen Consulting Group

The limited opportunities for collaboration with the remainder — the remainder of the countries are either small with limited resources or are coming from a weak base with the aid of EU funding. Their limited international co-operation programmes are focussed into the European area, including those countries about to join the EU, or selected high-technology countries such as US or Japan, countries with strong cultural links e.g. Spain with Latin America. This pattern seems set to continue although there will be individuals and institutions which will co-operate on projects on common interest as shown in Table 4.3.

Concerns about the Future Supply of Scientists and Technologists — an issue that is common to most of the countries is concern over the future supply of younger researchers, with declining interest in S&T among the young coupled with the ageing populations of most European countries. A number of countries see international collaboration as a way provide additional intellectual input to their research projects and possibly to recruit overseas researchers. It would be useful to examine data on mobility of Australian researchers to see whether collaboration has any negative aspects.

Barriers to Collaboration — there appear to be two main groups of barriers to collaboration that emerged from the material examined.

- *Bureaucracy, legal and funding issues* — lack of standardised contracts or other umbrellas to ease initiation of collaboration arrangements, as well as concerns over proprietary data and intellectual property rights over technology developed collaboratively, are seen as major barriers. Also participants in international agreements often have to use multiple funding sources, each with its own priorities and project requirements.

- *Culture, Communication and Logistics* — difficulties in developing a common frame of reference and research plan and reaching an understanding across a group with different backgrounds can be barriers. The ability of participants to communicate effectively and to keep international collaboration informed over the long distance between Australia and Europe has been a problem in some projects.

These potential barriers need to be recognised when considering international collaboration with Europe.

Measuring Outcomes of Collaboration — in benchmarking international collaboration, various measures have been used.

- Research products, co-authored publications and joint patents are widely used (see Figure 4.1). Other measures are models, software, new data and methodologies although these sometimes present difficulties in evaluation due to the tacit knowledge involved.

- Numbers of researchers involved is another measure although this does not measure quality of collaboration.

- Creation of lasting networks with exchange of information and potential for further collaboration can be a valuable outcome although again difficult to measure.

Appropriate measures need to be employed to measure the success or otherwise of international collaborations with Europe.

4.8 General Conclusions

As can be seen in Table 4.6, European country priorities mesh well with most of Australia's National Research Priorities (listed in Appendix I). While there are a few areas such as Earthquake protection (Greece) and Mediterranean civilization in the global system (Italy) that are not relevant, other European national priorities are similar to those of Australia. For example, biotechnology, ICT, genome research, optoelectronics, microelectronics, materials technology, robotics and manufacturing technology fall within Australia's "Frontier Technologies" category.

At a finer level of disaggregation, the assessment of this study is that apart from some Australia-specific priorities (such as protecting Australia from invasive diseases and pests, and sustainable use of Australia's biodiversity), all of Australia's National Research Priorities can find a match in Europe, especially among the larger European countries.

In relation to the European Union's own priorities, Australia's priorities map well against those of the Sixth Framework Programme with the exceptions of Aeronautics and Space (see Table 4.2).

Countries in Europe and the EU itself place considerable importance on international S&T networks. As the studies cited in this Chapter show, European countries have found these networks to be a cost-effective way of building and maintaining research strengths. This is particularly true of the smaller countries, which would otherwise lack the depth and breadth in emerging areas of technology that may be important to their future economic and social goals.

For Australia to be attractive as a partner in these networks, especially given our distance from Europe, we must be seen as having something special to offer (excellent researchers with leading edge research facilities). This is discussed further in Chapters 8 and 9.

Many European countries have international S&T cooperation arrangements with Japan, China and Korea and this cooperation takes place through bilateral agreements.

Because the European Union provides larges amounts of funding for international S&T within Europe, smaller European countries tend to not have significant international programs of their own. However, as the INCOPOL study shows, most have pluralist national S&T systems in which support for international S&T is provided through multiple sources.

European countries, particularly France, the United Kingdom, Germany, Italy, Austria, Sweden and Finland maintain sizable networks of science counsellors around the world and use these networks to facilitate international S&T links. Australia lacks such a network and the supporting resources necessary to maintain an up-to-date knowledge of opportunities and to develop strategies to address those opportunities.

As the INCOPOL study has noted, European countries have recognised the need for seed funding and rapid response mechanisms in order to ensure that researchers can explore new international S&T cooperation opportunities as and when they arise.

Again, the INCOPOL study has highlighted (see section 4.1) the importance of cooperation in 'big science' projects (megascience). This importance is also apparent from other documentation reviewed for the present study. The drivers are the opportunity to work in research teams tackling leading edge challenges, access to state-of-the-art equipment or to world-scale network projects, all at an affordable price.

Within Europe, most countries have coordination mechanisms in place to manage international S&T activities. These tend to be high-level bodies with a secretariat in a central coordinating agency – in the UK The Cabinet Office fulfils this function. There is also strong S&T coordination with Europe through the EU, COST, EUREKA and the European Science Foundation (ESF).

The data in this study demonstrate strong interest in S&T cooperation with Europe, and a good match between European and Australian priorities. There is an apparent willingness, on the part of European countries, to collaborate with Australia. The cooperation opportunities in Europe, especially those with the EU, are unique and offer Australia access to Europe's best researchers. However the excess demand for IAP-IST funds indicates that there is a need for a significant increase in funding if the benefits of increased international S&T cooperation with Europe are to be realised.

Chapter Five

US International S&T Linkages and Research Priorities

Gross Expenditure on R&D (GERD) in the US in the year 2000 was approximately $US260,000 million. At current exchange rates, this is equivalent to $A394 billion. As a percentage of GDP, GERD amounted to 2.76 per cent. The US is probably the only OECD country with an innovation system that is nearly self-sufficient. Even so, the US is actively involved in S&T co-operation with many countries.

5.1 Analysis of US International S&T

The RAND report published in 2000[18] finds that developments in S&T are increasingly the result of international co-operation and is changing the conduct, organisation and outputs of scientific research around the world. The report concludes that scientific research is becoming more globalised, more collaborative and more distributed (collaboration over longer distances and involving more widely dispersed expertise).

These circumstances present certain challenges to nationally based S&T policies. From a US perspective, RAND identified the following challenges.

- To what extent do US taxpayers accrue benefits from US investments in S&T?
- Has US investment in scientific capacity-building overseas succeeded to the point that it has created collaborators and competitors?
- What are the implications of increased international S&T for governance of R&D in the US?

In order to answer these questions, the RAND study sought to ascertain the following:

- how much the US government spends annually on international co-operation.
- who spends these funds; and
- where the funds are being spent.

The RAND study concludes that the US Government spent approximately $US4.4billion[19] on international S&T in fiscal year 1997. This amounted to approximately 6 per cent of the total Federal S&T budget of $72 billion and represented a major increase from the $US3.3billion found in their previous study (which had been based on 1995 data). The report classifies areas of activity, including research collaboration, technical support, operational support, conferences, database development, technology transfer and standards development. The majority of these activities take place in the US. RAND provides a detailed analysis by field of science and by agency supporting international co-operation in R&D. Aerospace (mainly

[18] RAND, 2000, RAND, 2000, *International Cooperation in Research and development: An Update to an Inventory of US Government Spending*.

[19] The exchange rate used in this report is $US1 = $A1.52, making the RAND figure $A6.8b. Adjusting for inflation and subsequent increases in expenditure, the current annual figure is estimated to be in excess of $A7.4b.

NASA) is by far the largest element. Biomedical science a distant second, followed by engineering sciences.

The RAND report indicates that many relevant activities are not included in these estimates. This is because they are embedded within institutional programs.[20] In addition, the report recognises that much informal S&T collaboration has not been captured (RAND counted only those international S&T activities which received dedicated funds). As a consequence, RAND estimates that the real US expenditure on international S&T in fiscal year 1997 was likely to have been as much as half again (or another $US2b).

The US General Accounting Office (GAO) reported a detailed analysis of activity under US Government international S&T agreements in 1999.[21] It examined the participation of seven major US S&T agencies in 575 agreements, involving fifty-seven countries and eight international organisations. It found that more than 90 per cent of these agreements resulted in research projects or related activities.

5.2 Key Agencies — Roles and Priorities

Office of Science and Technology Policy

The Office of Science and Technology Policy (OSTP) advises the President and others within the Executive Office of the President on the impacts of S&T on domestic and international affairs. The mission of OSTP requires it to serve as a source of scientific and technological analysis and judgment for the President with respect to major policies, plans, and programs of the Federal Government. The main role of the OSTP is to:

- lead an interagency effort to develop and implement sound S&T policies and budgets;
- work with the private sector to ensure Federal investments in S&T contribute to economic prosperity, environmental quality, and national security;
- build strong partnerships among Federal, State, and Local governments, other countries, and the scientific community; and
- evaluate the scale, quality, and effectiveness of the Federal effort in S&T.

OSTP plays a key role in international S&T policy and in the determination of US priorities in S&T. OSTP provides the secretariat to the National Science and Technology Council (NTSC) and its committees.

The NTSC's Committee on International Science, Engineering and Technology (CISET) was established to provide overall guidance and direction to US international S&T effort.[22]

The NCST recognised that some of today's most difficult scientific and technological problems cannot be solved by the United States acting alone. The intellectual and financial resources needed to address such issues as protecting the environment,

[20] In our case, a similar problem arises with government laboratories such as the CSIRO where researcher time is the major cost.

[21] US General Accounting Office (GAO), 1999, *Federal Research – Information on international Science and Technology Agreements*, GAO/RCED-99-108, Washington.

[22] See http://www.ostp.gov/nstc/html/committee/ciset_charter.html

developing sustainable energy sources, or identifying the fundamental structure of the Universe, can only be mustered on the basis of international co-operation. Many parts of the US scientific agenda inherently require international co-operation, for example, the study of the causes and effects of global climate change. Other parts of the agenda naturally invite collaboration because of unique foreign expertise or facilities.

Participation in international collaborative projects requires careful analysis, planning and interagency coordination. On one hand, higher levels of international co-operation support continuing US leadership in S&T. On the other hand, the NCST believes that this co-operation must serve the US national interest: the advancement of US economic competitiveness, global stability, sustainable development and other elements of national security.

CISET addresses international scientific co-operation as it relates to foreign policy and the nation's research and development agenda. The main function of CISET is to develop, on an interagency basis, policies for furthering international S&T co-operation in the national interest. CISET is a good model for coordination of international S&T in Australia. More information about CISET is provided in Appendix G.

OSTP International Priorities

OSTP lists four bilateral relationships that are currently a priority - China, India, Mexico and Japan.

China — in 1979 the US and China signed a Science and Technology Agreement, focussing on the areas of: water resources; oceanic and climatic disasters and earthquakes; agriculture; basic and mega-science; and transpacific pollutants.

India — OSTP is actively working to rebuild the US science relationship with India. S&T is one of the key pillars of this new relationship. OSTP has developed a high level dialogue between the various science communities of both governments.

Mexico — the US-Mexico S&T bilateral relationship is reported to be part of current North American free trade discussions. A high-level meeting in May 2000 assessed and refined opportunities for expanded S&T collaboration. Participants agreed to create an ad hoc bi-national panel of experts to identify and recommend best opportunities for future areas of S&T co-operation. It also agreed to expand co-operation in the areas of:

- science education for children;
- biocomplexity and the environment;
- the relationship between a climate event such as El Nino and ecological changes;
- infectious disease;
- digital libraries;
- computer simulation of natural phenomena, such as climate and earthquakes; and
- a scientific study of the biological and sociological basis of drug addiction.

Japan — the most recent high-level meeting between Japan and the US discussed a report prepared by sixteen prominent scientists from both nations that highlighted the key areas for future action. The issues discussed were divided among three themes: new frontiers in science and technology, science and technology and 'liveability', and social, ethical, and decision-making aspects of science and technology policies.

Japan and the US collaborate in a number of areas that including: human genome research, plant genome research, biocomplexity, global change and climate prediction, cybersecurity, ageing, transportation, natural disaster mitigation, energy, environment and economic Growth, science Education and Public Awareness, ethics and social responsibility, and decision making in science and policy.

The US, like Australia, is actively engaged in multilateral fora such as APEC and the OECD. In addition the US plays a key role in the Organization of American States (OAS). OSTP works with the OAS Office of Science and Technology Policy to develop, foster and support activities that contribute to the advancement of science and technology in the Member States.

Recent past OSTP priorities, most of which continue in various forms, include:

- research on emerging infectious diseases;
- the Millennium Vaccine Initiative designed to accelerate the development of vaccines for diseases such as AIDS, malaria, and tuberculosis, which disproportionately affect less developed countries;
- agricultural biology capacity building in Developing Countries;
- global science and technology co-operation;
- green chemistry;
- international water issues; and
- IPR model annex in umbrella S&T agreements.

Although overall leadership for international science and engineering policy lies in the White House within OSTP, the focus of OSTP understandably is selective, with emphasis on the early stages of an issue, on critical day-to-day issues of diplomacy and security, and on general oversight. Implementation and follow-through on international S&T activities are mostly left to other agencies.

The National Science Foundation (NSF)

The NSF provides leadership on such crosscutting matters as international scientific infrastructure, global change research, and the international mobility of human resources. The Foundation also implements a large number of formal, government-to-government bilateral science and engineering programs. The National Science Board (NSB) is the governing board of the NSF and also provides advice to the President and Congress.

The NSF mission and its strategic objectives include both a broad and a specific mandate for international activities. The provisions of the NSF Act that relate to international science and engineering give the Foundation broad responsibility in the international science and engineering research and education arena.

NSF estimates that it invested about $US350 million in FY 1997 on activities with significant international dimensions.[23] Of this total, $25 million was allocated for the Division of International Programs (INT) whose programs are explicitly dedicated to the support of international activities. These estimates are similar to the RAND estimates included in Table 6.1.

Specific NSF programs and policies supporting international S&T activities are summarised at the end of this section and include support of overseas offices in Paris and Tokyo, research collaborations, conferences and workshops, information and data sharing, postdoctoral fellowships, and summer programs for graduate students. INT staff carry out a number of important service and brokering functions including provision of advice and expertise, internal knowledge and information transfer, communication with counterparts in other countries, linking of individuals and small research groups with similar interests, and provision of seed money for exploratory programs.

Other NSF programs directed specifically towards the support of international activities are:

- the foreign data activities of the Division of Science Resources Studies;
- the NSF-NATO Postdoctoral Fellowships in Science and Advanced Study Institutes Travel Awards programs managed by the Directorate for Education and Human Resources (EHR); and
- the international networking program, managed by the Directorate for Computer and Information Science and Engineering (CISE).

A Taskforce of International Issues in Science and Engineering reporting to the National Science Board (NSB) in November 2001 observed that:

> 'The significance of science and technology in the global context has grown dramatically, and both private sector and government co-operation in international science and engineering have assumed more prominent roles. Many problems of the 21st Century will demand more information, more participation by the scientific communities of all nations, and more co-operation between these communities and decision makers'.[24]

The Task Force recommended a greater leadership role in international S&T for the National Science Foundation (NSF). More specifically the report included a number of recommendations.

- International S&T should become a higher priority for the NSF, with a much stronger focus and a much higher level of visibility.
- NSF should emphasise international considerations more explicitly in its research and education programs.
- NSF should review its resource allocation and organisational structure in order to implement the report's recommendations.
- NSF should expand its efforts in disseminating information about US international science and engineering research.

[23] http://www.nsf.gov/nsb/documents/2000/nsb00217/nsb00217.htm accessed on 21 July 2003.

[24] National Science Board, 2001, Interim Report by the Task Force on International Issues in Science and Engineering, *Toward a more effective role for the US Government in international Science and Engineering*, Washington, access at http://www.nsf.gov/nsb/documents/nsb00217/nsb00217.htm.

- NSF could also provide leadership in working with central agencies {the Office of Science and Technology Policy (OSTP) and the Office of Management and Budget (OMB)} to enable the development of cross agency mechanisms for collecting and disseminating the data needed for better coordination and planning.

The 2001 report of the NSB Task Force focused on ways of improving the effectiveness of the role of the Federal Government in international S&T. Its major finding was that there is a need for more effective coordination of US Government international S&T and international S&T-related activities, and greater consistency in meeting international commitments in this area.

Since the structure of US international S&T activity is not unlike that of Australia, it is interesting to note that the NSB report concludes that:

> 'Retaining the status quo would jeopardize future US economic and scientific leadership and the Nation's ability to address important global problems'.

The final NSB Task Force report called for new approaches to the management, coordination and funding of international S&T activities, with increased responsibilities for the OSTP. It recommended the preparation of an annual international S&T budget statement across all agencies, similar to that prepared annually for R&D expenditure, and including international activities outside specifically designated international programs.

The NSB report also expressed concern that international S&T agreements are not adequately supported with appropriate funding, recognising that some require longer-term commitments. Other recommendations addressed the need for increased use of science and engineering information in foreign policy deliberations and in dealing with global issues and problems.

In today's world, NSF cannot achieve its goals in isolation. Increasingly in the future, US scientists and engineers must be able to operate in teams composed not only of people from many disciplines, but also from different nations and cultural backgrounds. New ideas emerge from the intellectual interactions of people from diverse backgrounds everywhere and in every country. Many scientific tools, both large facilities and large distributed and networked databases, will necessarily involve international partners. NSF undertakes or participates in international activities whenever it contributes to accomplishing NSF's overall goals more effectively.

NSF's Office of International Science and Engineering (INT) is currently effecting the Board's recommendations including efforts to make the NSF's investments in international science and engineering more strategic and strengthening the focus on and visibility of international collaborations both in core disciplines and in NSF wide initiatives.

The State Department

The State Department is statutorily mandated to approve all proposed international agreements. For all routine S&T agreements (except those related to space or health) this responsibility is delegated to Office of Science and Technology Co-operation (STC), which manages the interagency review and clearance procedure. STC has developed a handbook clarifying procedures and distributed it throughout the US Government.

The mission of the STC within the State Department provides policy coordination, facilitation, and promotion of international S&T co-operation involving US Government technical agencies and their overseas counterparts.

Among STC's primary responsibilities is the negotiation and management of government-to-government framework science and technology agreements with thirty-four countries and the EU. These agreements facilitate many hundreds of individual cooperative activities (implementing arrangements) between US Government agencies and their foreign counterparts. They also promote protection of intellectual property rights, while helping to secure equal access to information and facilities. The main role of the STC is to:

- head periodic interagency reviews of bilateral science and technology co-operation which results in recommendations for S&T priorities;
- frequently lead delegations to joint S&T commission meetings established under the agreements, as well as to a variety of international S&T conferences;
- manage joint science and technology funds with about one-quarter of the countries with which we have framework agreements;
- organise educational roundtables for the State Department on S&T topics such as protection of intellectual property and nanotechnology;
- sponsor efforts to promote co-operation between the US science community and the US Government agencies responsible for implementation of immigration law (State Department and the Immigration and Naturalization Service) to better coordinate US visa policy and the increasing need for global mobility of scientists; and
- seek opportunities for expansion of S&T co-operation into new areas, such as disaster relief/mitigation technologies.

5.3 Overview of International S&T Activity

In its conclusions presented in its 2000 report,[25] the RAND Corporation noted that it is difficult to say where national research activities end and international co-operation begins. RAND counted as international government S&T expenditures only those projects where the description clearly stated that international collaboration was a goal.[26] They also limited their analysis to R&D rather than S&T. RAND found that many international projects actually took place in the US, which is to be expected given their excellent research facilities.

Table 5.1 details international R&D expenditures by key agencies in US Fiscal year 1997 — the year chosen for analysis by RAND.

RAND used a 'bottom up' methodology similar to that used in this study. This involved starting with individual projects, and aggregating up to programs and then to agencies.

The RAND team also had difficulty in identifying S&T expenditure over and above R&D expenditure. It noted that R&D data differ across US agencies in relation to accounting for salaries and indirect costs. The RAND team used R&D budget dollars because they are identifiable, generally comparable and traceable. S&T data included R&D and other government activities that support science.

[25] RAND, 2000, *International Cooperation in Research and development: An Update to an Inventory of US Government Spending*, accessed at http://www.rand.org/publications/MR/MR1248/

[26] The definition used by the RAND team is not the same as that used in this report.

Table 5.1

US AGENCY SUPPORT FOR INTERNATIONAL CO-OPERATION IN R&D (1)

Agency	Estimated international spend1997 ($US million)	Total R&D budget 1997 ($US million)	International spend as a percentage of total R&D (per cent)
National Science Foundation	206	2,248	9.2
National Aeronautics and Space Administration	3,151	9,038	34.9
Dept of Defence	263	37,322	0.7
Agency for International Development	225	225	100
Dept of Health and Human Services	215	12,488	1.7
Dept of Energy	183	5,453	3.3
Dept of Commerce	41	915	4.5
Environmental Protection Agency	21	539	3.9

Source: RAND, 2000
Note: Totals have not been provided in this table because some smaller agencies are not included.

In order to be counted in the RAND study, a project had to have undertaken co-operation with entities in other nations as one of its principal purposes. It should be noted that this study of Australian international S&T has gone beyond the RAND criterion and attempted to include international components of what are predominantly national activities.

RAND concluded that the US Federal Government spent approximately $US4.4 billion ($A6.7 billion) on international co-operation in R&D in 1997. This represented about 6 per cent of the total Federal R&D budget of $US72 billion – a significant increase on the figure for Fiscal Year 1995, which RAND attributed in part to growth in expenditure, and in part to improved reporting.

The RAND team noted that there were a number of government–funded international S&T activities that they were unable to measure. In addition, there were cases where agency data clearly underestimated the extent of international activity. For these reasons, RAND estimated that the actual figure for government-supported international S&T co-operation could be fifty per cent higher than the $US4.4 billion figure reported above.

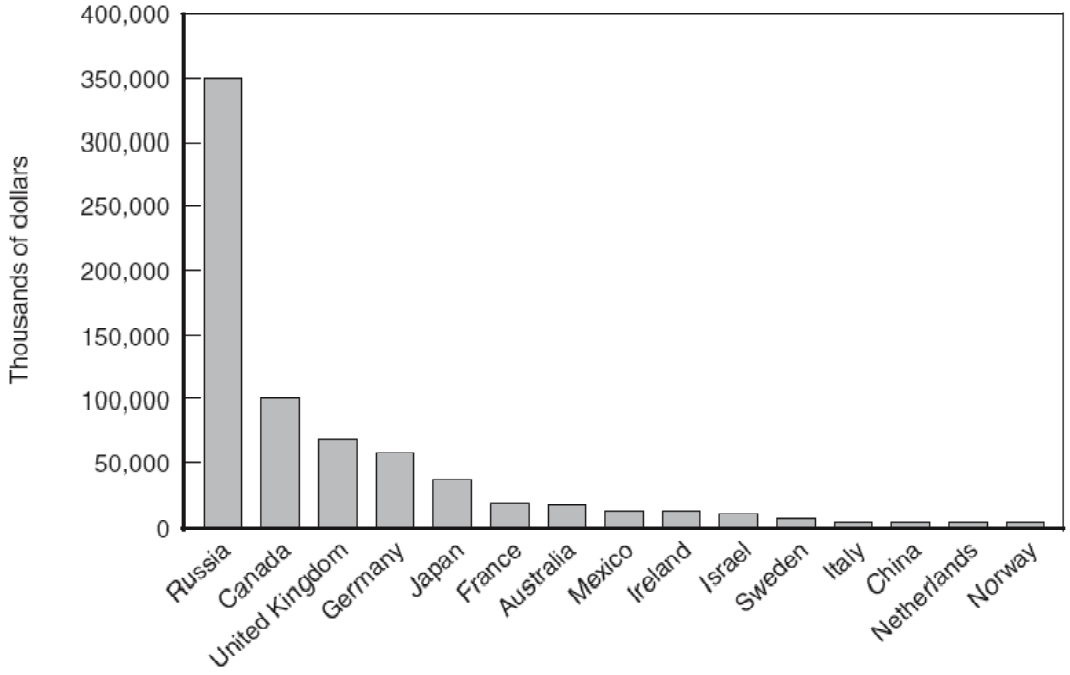
In the US, multinational S&T cooperation, defined as projects involving researchers from more than two countries, accounted for $US3.6 billion of total international S&T in 1997. The RAND study states that the reason for multinational cooperation dominance is the substantial financial investments required for big science projects. For example, $US2.6 billion of multinational cooperation was undertaken by NASA, and even this $US2.6 billion excludes the Space Shuttle program, as well as three quarters of the total spending on the international Space Station.[27]

[27] RAND states that although the Space Station is an international science project, only one quarter of the total spending on the Space Station involved direct collaboration with other countries and therefore could be included in calculations of expenditure on international S&T (RAND, 2000, *International Cooperation in Research and development: An Update to an Inventory of US Government Spending*, p20).

Binational cooperation is defined as projects involving the US in collaboration with researchers from just one other country. Binational projects account for $US1 billion of US spending on international S&T, with the largest partners being Russia, Canada, the UK, Germany and Japan. Binational projects with Russia ($US390m in FY97) clearly dominate, as shown in Figure 5.1. Here, the majority of expenditure on Russia projects was in the field of aerospace and aeronautics. Figure 5.2 illustrates the presence of US binational collaboration in all parts of the world. Again the dominance of Eastern Europe (42 per cent) is mostly a reflection of Russian projects.

Figure 5.1

US BINATIONAL S&T COLLABORATION BY COUNTRY, FY 1997



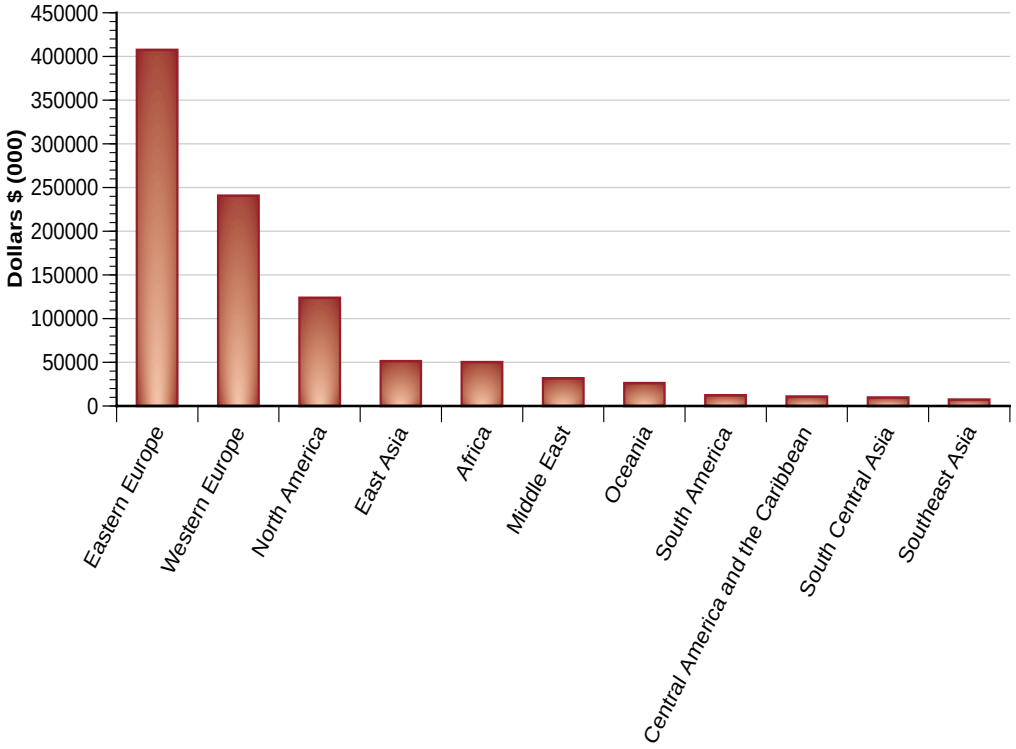
Source: RAND, 2000
Note: Binational collaboration represents about $US1 billion of total international collaboration ($US4.4billion).

Both multinational and binational projects are included in an analysis of collaboration by field of science, shown in Figure 5.3. This figure does not include aerospace and aeronautics (over $US3 billion in FY97) since projects in this field accounted for more than half of expenditure on single fields of science. Biomedical sciences ranks a distant second and represents 7 per cent of total US collaborations.

The RAND study found that US S&T collaboration with Australia had fallen dramatically in FY 1997 to $US19.6 million ($A29.8m at the present exchange rate), from $US88 million in 1995. However, this decrease was attributed to a single item – the completion of US Defense Department contracts for a shared control ground station satellite system. No conclusion can be drawn about levels of non-defence S&T cooperation.

Figure 5.2

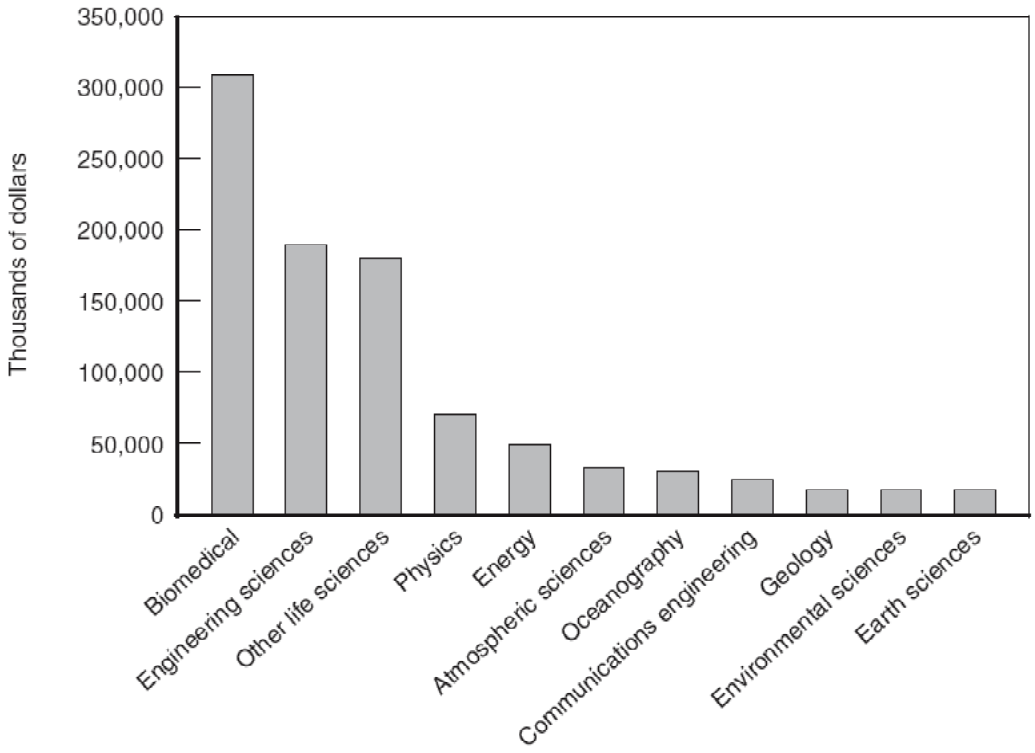
US BINATIONAL S&T COLLABORATION BY REGION, FY97 ($US 000)



Source: RAND, 2000
Note: Binational collaboration represents about $US1 billion of total international collaboration ($US4.4 billion).

Figure 5.3

COLLABORATION BY FIELDS OF SCIENCE, EXCLUDING AEROSPACE, FY 1997



Source: RAND, 2000
Note: Aerospace & aeronautics (>$US3.1 billion) represent more than half the total expenditure.

5.4 Programs Supporting International S&T

Most US Government agencies are involved in supporting international S&T activities. Major players include the NSF the NIH and the Department of Defense. Generally available support is provided through the NSF.

The NSF is committed to the principle of open and reciprocal access to research and education facilities and programs by US researchers and those of other countries. The Foundation encourages the US scientists and engineers it supports to develop their own links with researchers in other countries. The Foundation supports offices in Tokyo and Paris. Their function, in part, is to monitor developments in Japan and in Eastern and Western Europe of significance to NSF management.

The Foundation also maintains a range of intergovernmental agreements and other less formal arrangements with science and engineering organisations in other countries. Some of these (including agreements with China, Japan and Russia) are elements of broader intergovernmental agreements managed by the Office of Science and Technology Policy, the Department of State, and other Federal agencies.

The Foundation maintains and participates in over a dozen formal bilateral agreements (for example with Brazil, China, France, Hungary, Indonesia, Japan, Korea, Mexico, Czech Republica and Russia) and about twice that number of informal bilateral arrangements for co-operation in all NSF-supported areas of science and engineering

Some examples of US international S&T collaborations and support are provided here.

Global-Scale Projects and Research Networks — the National Science Foundation plays a lead role in more than two dozen international-scale projects and is a major participant in many others. The Foundation provides substantial financial support for these projects and the Foundation's senior management and staff play major roles in shaping, managing and coordinating the programs in both national and international contexts.

NSF Support for International Facilities — the Foundation supports a number of facilities that are predominantly international in character. Some of these facilities are located overseas, where there are explicit frameworks for multinational support, with foreign contributions often provided in-kind. In those cases where the facilities are located in the US, construction and operating costs are often (but not always) borne by the Foundation. The Gemini North telescope near the summit of Hawaii's Mauna Kea is an example of cost sharing for an international S&T facility. Some facilities involve institutional agreements and arrangements with partner institutions in other countries. An example of such a facility is the NSF's National Centre for Atmospheric Research, which engages in a number of collaborative programs involving atmospheric research institutions in Canada, Germany, Australia, and Russia.

Overseas Facilities — the international facilities supported by NSF include the design, development, and construction of facilities for ground-based astronomy research. Since such facilities are increasingly complex and costly, it is more and more common to seek partnerships, including international ones, to enhance scientific, technical, and educational value and increase cost effectiveness.

Joint Programs with other Countries — the Foundation supports joint programs designed to facilitate the involvement of NSF-supported US scientists and engineers in international collaboration: examples include a joint program with Japan, the US-Japan Joint Optoelectronics Program (JOP) which promotes the supply of prototype optoelectronic devices and services for development of computing applications. Importantly, the JOP offers a secure and convenient system for offering and obtaining optoelectronic prototypes.

Access To Foreign Facilities And Research Groups — some the areas of science and engineering in which significant international interaction occurs are the physical sciences, especially physics and materials research. For example, in atomic, molecular, and optical physics, NSF supports US researchers working at CERN, KEK (Japan), Rutherford-Appleton (England), and in France, Germany, and Brazil. In materials research, between 10 and 15 per cent of NSF-supported researchers are engaged in research collaboration with foreign scientists and as many as half of them take sabbaticals overseas.

Participation in International Meetings — the Foundation enables an estimated 5,000 US scientists, engineers, and educators to participate in international research and education related meetings. Much of this support is provided under research grants, some as block grants. The meetings range from large international science and engineering conferences to seminars or workshops for the planning and development of international projects and programs. NSF also provides support for conferences, bilateral seminars and workshops for the planning and development of international projects and programs.

International Experiences for New Scientists and Engineers — in pursuit of its mission to invest in a diverse, internationally competitive and globally engaged workforce of scientists and engineers, the Foundation uses both fellowships and participation in research to provide US students and early career scientists and engineers with opportunities to gain international professional experience. The majority gain that experience through participation in international research projects. Many others become involved internationally through the Foundation's fellowships programs.

One example is the International Research Fellowship Program (IRFP), which provides support to conduct research at science and engineering establishments in all foreign countries. Applicants are eligible in any area of science and engineering supported by NSF and may conduct their research anywhere in the world. IRFP is supplemented by another program — Research Fellowship Opportunities in Japan, conducted in partnership with Japanese agencies.

Programs for graduate students include the NSF Summer Programs in Japan, Korea and Taiwan. Over one hundred US graduate students in science and engineering participated in the program in 2000. Since their start in Japan in 1990 and in Korea in 1995, the programs have enabled a total of over 700 American graduate students to gain first-hand experience in a research laboratory in Japan, Korea, or Taiwan.

5.5 US National S&T Priorities

As Dr Neil Lane, Science Adviser to President Clinton noted,[28] there are three things that interfere with national S&T priority setting in the US.

- The US has a distributed system of research and development in which agencies' missions are paramount to other considerations. Agencies set their R&D priorities – often with the help of advisory councils and broad consultation throughout the scientific community – by assessing the potential contributions of research to their mission needs. Some, but not all, agency missions explicitly include advancement of science and technology. In most cases, S&T goals are simply part of overall agency objectives.

- In seeking to plan for national S&T priorities, budget constraints need to be recognised.

- The role of Congress has to be taken in to account. The annual budget cycle favours spending with short-term outcomes. This makes it hard for research to compete for government funds.

In the US, priorities tend to be set in the context of the annual budget process. To understand priorities in a US context, it is necessary to understand the budget formulation process.

First, the Executive Office of the President issues guidance to help the agencies develop their budgets according to the President's priorities. The Office of Management and Budget (OMB) issues agency-specific guidance that covers S&T priorities to varying degrees. OMB and the Office of Science and Technology Policy (OSTP) also work together to prepare separate guidance on R&D priorities. This advice reiterates national goals for S&T investment and identifies national priorities — referred to as 'interagency areas of special emphasis'.

The OMB/OSTP advice is a key part of the priority-setting process and influences how competing budget requests are resolved. It is prepared under the auspices of the National Science and Technology Council — a group chaired by the President that includes the Cabinet Secretaries and Agency heads of all departments and agencies that conduct R&D. The cross cutting, multi-agency initiatives highlighted in the guidance memo represent the work of program staff in all the agencies involved.

These cross cutting interagency initiatives represent an effort of the NSTC to identify the top priorities for research that depends on the particular talents of many agencies to succeed. Through a consultative process involving NSTC committees and their subcommittees, those interagency R&D initiatives are identified which are assessed as having the greatest promise to advance the President's priorities and national goals.

OMB then holds hearings on agency budget submissions and on the interagency initiatives. These hearings are followed by the 'passbacks' to the agencies (directions on how they should modify their requests to better reflect Presidential priorities and budget realities). The passbacks provide a second chance for adjustments, up or down, to the overall S&T portfolio, although it is still effected agency-by-agency.

[28] Lane, N, 1999, Presentation to the National Science Board Symposium on International Models for R&D Budget Coordination and Priority Setting, accessed at http://www.ostp/gov/html/00222_3.html on 14 July 2003.

Finally, the White House reviews the budget proposal submitted by OMB to the President. This review is done on an agency-by-agency, initiative-by-initiative basis. Many priorities compete for scarce dollars, but still the process provides an opportunity for top-down consideration of a national R&D portfolio.

The President then submits his budget to the Congress where it is subject to hearings, amended and eventually adopted.

In reporting priorities in the next two sections budget figures have been included in order to indicate the magnitude of the resources allocated to these areas. It should be noted that in the US the President's budget is subject to amendment by Congress. It is difficult to track these amendments. We have therefore followed an approach of documenting the Presidential budget proposals because they provide a clear statement of Administration priorities.

Clinton Administration Priorities

Once priorities have been adopted, they influence S&T activity for several years. For this reason it is useful to examine international S&T activities from 2001.

NSTC priority programs for Fiscal Year (FY) 2001 are listed below. These activities continue to be US priorities in 2003 and to receive significant levels of funding.

- **Information Technology R&D —** integrating previous initiatives including the Information Technology for the Twenty-first Century initiative, High Performance Computing and Communications. The integrated program was to stimulate innovations such as digital government, tele-health and environmental monitoring.
- **US Global Change Research Program (USGCRP) —** which implemented the carbon cycle initiative begun in FY 2000 and examined and sharpened the focus of climate observing and modelling programs.
- **Climate Change Technology Initiative —** aimed to promote research aimed at achieving reductions in US carbon emissions at the lowest possible cost, including technologies that reduce greenhouse gas emissions and increase the efficiency of energy and materials used in transportation, buildings, and manufacturing, while lowering the costs of renewable alternative technologies.
- **Emerging Infectious Diseases (EID)** — initiated a new phase in the interagency effort to address emerging infectious diseases. Program priorities included Hepatitis C, antimicrobial resistance, emerging viral infections, pandemic influenza, and the effort to address global emerging infectious disease challenges.
- **Protecting Against 21st Century Threats** — promoted and coordinated research to reduce vulnerabilities in critical national infrastructure; promote the development of technologies that will detect, contain, and mitigate attacks against or other failures in these infrastructures.
- **Aviation Safety, Security, Efficiency, and Environmental Technologies —** aimed to reduced the aviation fatal accident rate by eighty percent by 2007 and strengthening the security of the US aviation system.
- **Plant Genome —** supported the development of plant genomic technologies, and improving understanding of plant biology and be applied to the enhancement of economically important plants.

- **Food Safety** — promoted food safety research that provided a scientific foundation for sound food safety policy and regulation.
- **Integrated Science for Ecosystems Challenges** — aimed at the knowledge base, information infrastructure, and modelling framework to help resource managers predict/assess environmental and economic impacts of stress on vulnerable ecosystems.
- **Educational Research Initiative** — understanding of the learning process and to apply that understanding to the development and evaluation of educational systems and technologies.
- **Nanotechnology** — promoted and coordinated a long-term nanoscale R&D agenda targeted at potential applications including nanoparticles for improved drug delivery, miniature sensors for earlier detection of ovarian cancer, computer chips capable of storing trillions of bits of information on a pin-head, advanced materials that are much stronger than steel, and artificial photosynthesis for clean energy.

Bush Administration Priorities

The Bush Administration has defined some new national priorities and continued to fund some priorities from the previous Administration. It has not articulated specific international priorities on a national level, and has mostly left individual agencies to decide how international S&T can contribute towards their missions and goals. New requirements for accountability and reporting have come into operation, which are likely to result in better reporting of international activities in the future.

The first Bush Administration budget (for FY 2002) requested a very small (1.4 per cent) total increase of $US300 million to increase the S&T budget from $US20.9 billion in FY 2001 to $US21.2 billion in FY 2002. While some agencies received small increases in funds, others (eg Dept of Energy) saw funding reduced. In summary, the actions in the budget included:

- the suspension of the Advanced Technology Program (ATP), which provides assistance to companies;
- a request for an increase of $US56 million for NSF;
- a reorganising of research in Astronomy and Astrophysics, including an increase NASA's S&T funding by 2 per cent in FY 2001.
- a $2.6 billion initiative ($US20 billion over five years) for the Department of Defense to fund R&D of new technologies.

The Administration's FY2003 Research and Development Program involved:

- a 9 per cent budget increase of $US9.3 billion taking the total to $US111.6 billion;
- a $US46 million increase to the Department of Defence;
- a $US3.7 billion increase for the National Institutes of Health (NIH), for continued funding for research on AIDS, Tuberculosis and Malaria. The AIDS research budget increased to $US2.9 billion;

- $US8.3 billion for the Department of Energy for R&D on advanced fuel cell vehicles (FreedomCAR), High-Temperature Superconductivity, the President's Coal Research Initiative, and Nuclear Power 2010.

For FY 2004, the President has proposed a 7 per cent increase ($US7.7 billion) in Federal spending for R&D, bringing the total to $US122.7 billion. Nearly 70 per cent of the increase ($US5.3 billion) will go to the Department of Defence, with the new Department of Homeland Security receiving a $US1 billion for R&D, an increase of 32 per cent from FY2003. In summary:

- the NSF is proposed to receive a 9 per cent rise in funding, taking its budget to $5.5 billion;
- the NIH, would receive only a 2 per cent increase, including $US1.75 billion in new funding for bioterrorism-related research;
- S&T research at the Department of Energy will rise about 3 per cent, mostly for nuclear energy programs. Hydrogen R&D will be the only renewable energy to maintain its funding, reaching $US104 million in FY 2004; and
- the Environmental Protection Agency (EPA), will receive additional funding for priorities including research on the health effects of industrial chemicals.

The nearest thing that the US Government has to an overall S&T strategy is the instructions that agency heads are given in preparation of their next budget request. Interagency priorities for FY2005 are:

- R&D for combating terrorism;
- nanotechnology;
- networking and Information Technology R&D;
- molecular-level understanding of life processes; and
- environment and energy.[29]

5.6 Comments on the Co-operation Process and Barriers

A recent US National Research Council report recommended that the State Department transfer its responsibilities for management of bilateral and multilateral science and engineering agreements to other appropriate and willing Federal agencies when there is no compelling reason for retaining responsibilities within the Department. The report also recommended that the Department streamline its review process for proposed international agreements and bilateral memoranda of understanding, indicating 'delays and inefficiencies in the process are a constant source of irritation among departments and agencies and sometimes create difficulties with foreign collaborators'. NSF worked with the Department and other agencies in implementing these two recommendations and in identifying and correcting other unnecessary administrative barriers to international S&T collaboration.

[29] OSTP-OMB Budget Guidance Memo for FY2005, http://www.itri.org.

Other examples of administrative barriers include foreign scientists' difficulties obtaining timely visas at US Embassies, customs problems associated with moving scientific equipment needed for cooperative research into and out of countries, entry into territorial waters to do field research, and imposition of substantial research fees by local governments in some countries. The more general issues of intellectual property rights arising from international collaborations are also discussed as barriers to the free flow of research outcomes.

5.7 Conclusions

The US has strong international S&T relationships with industrialised countries ranging from high-level co-operation down to researcher-to-researcher co-operation. International co-operation is seen as an essential element in the US national science and innovation system and, as this analysis shows, its importance in the US has grown in recent years. The US, even with its immense domestic S&T resources, recognises that S&T is becoming more global and is seeking a greater involvement in this new global S&T effort.

US Government agencies are now tracking their international S&T co-operation. This results from increased accountability and reporting requirements of the GRPA. The impact of this Act is better transparency in US S&T expenditure generally and international S&T expenditure in particular.

Because of its resources, the US is able to invest significant funds in leading edge research and technology development. As a consequence, it is an important research partner for Australia. The US market for technology-based goods and services is strong and dynamic. As a consequence, a significant number of innovative Australian firms have US subsidiaries and undertake research activities in both the US and Australia. This suggests that Australia needs to be proactive in seeking out science and innovation partnerships in the US.

The US has strong, high-level coordination arrangements in place to manage its science and technology in its strongly pluralist system. These coordination arrangements extend to international S&T. The State Department and OSTP both have important roles in international S&T – something that is not currently mirrored in Australian administrative arrangements.

The US has recognised the need to provide generally available support for international S&T as well as through funding programs based on research excellence. In addition, the US provides special funding to assist early career researchers to become involved in international S&T.

National US research priorities are set through the annual budget process. There have been significant changes in national priorities since the election of President George W Bush. However, partly because of the multi-year character of much US funding and partly because of their intrinsic importance, Clinton Administration priority areas continue to receive significant funding. Most US priority areas identified in the Clinton and Bush Administrations are of interest to Australia.

The Bush Administration priorities have been strongly influenced by the events of 11 September 2001. As a consequence, they emphasise national security, anti-terrorism. Nanotechnology, genome research, climate change and high performance computing/networks continue to attract support. However, these are high-level priorities and it is necessary to look at individual agencies to understand what activities are attracting funding within the broadly defined high-level priorities. That said, at both high and more disaggregated levels, US priorities map well against Australia's National Research Priorities. Given the scale and strength of the US S&T system, it is unlikely that Australia researchers would not be able to find world-class partners in the US in almost any field.

In reality, any S&T area that Australia wished to designate as a priority is certain to be substantially better funded in the US. Thus encouraging Australian researchers to seek out and establish collaborative projects with researchers funded by the US will contribute to Australian S&T goals and provide access to a wide range of world-leading research laboratories. Commonwealth funding for this purpose will achieve significant leverage.

The only difficulty with US S&T co-operation in recent years has been US insistence on a new S&T Co-operation agreement which would have allocated intellectual property rights without regard to the size or nature of contributions, giving US researchers the US rights, Australian researchers the Australian rights and making no allocation in relation to the rest of the world. Australian officials have seen this approach as likely to be inequitable. It is understood that the US has recently changed its position on this matter.

In the meantime, many Australian researchers undertake joint research projects with US counterparts without any knowledge of the US employer's rules regarding intellectual property. This study has been informed of cases where Australian researchers visiting US laboratories received no benefits from intellectual property to which they contributed. There is a need to bring to the attention of Australian researchers the need to be aware of the intellectual property rules of foreign research partner organisations.

Chapter Six

Japan, China and Korea – International S&T Linkages and Research Priorities

In this Chapter, each country is discussed in turn and the conclusions can be found at the end in section 6.4

6.1 Japan

In the past, Japan's R&D strengths have been in applied research. In recent times, however, Japan has strengthened its basic research effort. As a percentage of GDP, GERD in Japan in 1999 was 2.93 per cent.

Key Agencies — Roles and Priorities

The Council on Science & Technology Policy (CSTP) has the primary responsibility for S&T policy. The CSTP is chaired by the Prime Minister and has representation from other Ministers, the Head of the Science Council of Japan and the Heads of some major national, public, private universities. The CSTP works through expert panels to investigate major issues including the implementation of priorities and strategies for promoting business-academia-government collaboration.

In 2001 the former Agency of Industrial Science and Technology was merged with MITI to become METI. The former Science & Technology Bureau was absorbed into the Ministry of Education, which became MEXT. In all, seven Ministries have significant S&T responsibilities. Several key organisations manage S&T programs, support R&D and promote international collaboration.

- The Japan Society for the Promotion of Science (JSPS) has responsibility for the advancement of science. With a budget of ¥116 billion ($A1.5 billion)[30] from MEXT, its main functions are to:
  - award grants under the Grants-in-Aid for Scientific Research and the 21st Century Centre of Excellence (universities) Program;
  - support young researchers through various measures, such as Research Fellowships Programs;
  - promote international scientific co-operation;
  - support scientific cooperation between the academic community and industry; and
  - collect and distribute information on scientific research activities.
- The Japan Science and Technology Corporation, with a budget of $A1.44 billion (of which approximately 80 per cent is provided by MEXT) is responsible for building up the S&T base, promoting leading-edge R&D and increasing public understanding of S&T. Current major activities include the promotion of "creative basic research", managing S&T information, and supporting research co-operation in Japan and internationally.

[30] In this Chapter, the conversion rate from Yen to Australian dollars is ¥1 = $A0.0128.

- Japan's New Energy and Industrial Technology Development Organisation (NEDO) supports a range of industrial development projects, with emphasis on coordination of resources and capabilities between the public and private sectors in Japan. Around 40 per cent of NEDO's annual $A3.2 billion budget for R&D is allocated to new energy sources and energy conservation technology.

  NEDO promotes international co-operation involving joint R&D and information exchange, largely focussed on energy projects and research co-operation projects under Japan's aid program. NEDO's budget for technology research and development in FY2001 was $A1.8 billion, provided by METI. Of this, ¥5 billion was allocated to materials and materials processing technologies, $A175 million to electronics and ICT, and $A197 million to biotechnology development. NEDO has an office in Sydney.

Japan has many Government-funded research institutes. The three major institutes are listed below with Fiscal Year FY2002 budgets shown. These institutes are actively involved in international S&T.

- Institute of Physical and Chemical Research (RIKEN) $A1.02 billion.
- National Institute for Materials Science (NIMS) $A247 million.
- National Institute of Advanced Industrial Science & Technology (AIST) $A1.14 billion.

National higher education institutions are fully funded by the Japanese government. Other higher education institutions are funded partly by local and partly by the national Government. In FY2001 there were 99 National universities, 74 prefectural universities and 496 private universities in Japan. These funds are provided through a range of mechanisms.

International S&T Activity

The Japanese government is seeking to internationalise Japan's S&T activities and establish teams of world-class researchers.[31] Initiatives in this area are driven by concerns about a perceived brain drain in recent years. The government is therefore seeking to create a world-class research environment in Japan which welcomes researchers from other countries. At the same time, the government is acting to encourage Japanese young researchers to study in a competitive environment of excellent overseas research institutes. International dissemination of information is also important. Japan wishes to disseminate R&D results to the world as well as supporting publication of research results in English in world-leading scientific journals. Government facilitates at Tsukuba Science City and Kansai Science City are international centres of excellence open to both Japan and the world.

Drivers of international co-operation include the need to solve global-scale problems such as global warming, food security, energy shortage, fresh water management, infections diseases prevention and disaster prevention/reduction.

The Government is strengthening partnerships with all countries, especially those in Asia. In addition, the government is promoting the protection and standardisation of intellectual property rights.

[31] Council on Science and Technology Policy (CSTP), 2001, *Science and Technology Basic Plan 2001-2005.*

Japan has S&T Co-operation Agreements with 37 countries. Under the 1980 Japan-Australia Agreement on Co-operation in Research and Development in Science and Technology, officials meet periodically to review the state of bilateral S&T cooperation. In addition, there are approximately 330 bilateral agreements in place between Japanese and Australian Universities. Nearly all these agreements include provision for research exchange and/or cooperation, although a number of these agreements appear to involve a very low level of activity.

The CSIRO undertakes a wide range of collaborative activities with Japanese research bodies in the fields of agribusiness, environment and natural resources, radioastronomy, manufacturing and construction, mineral and energy, and medical and health sciences. CSIRO has a formal research co-operation/exchange agreement with AIST and with RIKEN.

Of the approximately 130 research cooperation projects funded by NEDO under the International Joint Research Grant Program $A5 million in FY2002) since 1990 only six have involved Australian researchers. The CSIRO completed two projects under NEDO's International Joint Research Program in 2000 involving one collaboration with a US institute and a second with a German research institute on the development of high performance magnesium alloys and studies on a polymer membrane separation process for the petroleum refining industry. The JSPS reports 16 small Joint Research Projects undertaken in FY2001 under its bilateral programs with the Australian Research Council.

Japanese Government S&T policies give major emphasis to researcher exchanges. Activities supported under Government programs (in particular the MEXT Special Coordination Funds for Promoting S&T program) include sending researchers overseas, inviting researchers from overseas, bilateral and multilateral research projects and international workshops and conferences.

MEXT reports a steady increase over recent years in the numbers of research fellowships for Japanese and foreign researchers, with international exchange programs across the Japanese Government. In 2002 approximately $A400 million was budgeted by JSPS and $A38 million by the JST.

The countries most frequently visited by Japanese researchers under the JSPS programmes are the US, the UK and Germany in declining order. In FY2001 Australia received only five visits (or 2 per cent) of the total, compared to 144 (or 63 per cent) for the US. In FY2001, 70 Australian scientists were accepted under the JSPS invitation fellowships, postdoctoral fellowships and Bilateral Programs. In FY2002 there were 14 postdoctoral fellowships awarded by JSPS (in co-operation with the Australian Academy of Science) — significantly less than the number available to Australian scientists under the JSPS quota system.

Japan's National S&T Priorities

Japan's current national S&T priorities are described in the 2002 White Paper on S&T.[32] The White Paper states that 'aggressive and strategic investment in priority sectors, and promotion of research and development, are essential for ensuring sustained economic development through vitalization of the economy and industry, and for assuring the people of safe, secure lives'. The Japanese Government has selected four priority sectors: life sciences; information and communications; the

[32] Japan Science and Technology Corporation (JSTC), 2002, *White Paper on Science and Technology 2002*, Tokyo.

environment; and nanotechnology and materials. More details of these priority sectors are provided in Table 6.1.

Table 6.1

JAPAN'S FOUR PRIORITY SECTORS

Life Sciences	*Information & Communications*	*Environment*	*Nanotechnology & Materials*
Priorities	***Priorities***	***Priorities***	***Priorities***
• Health-related Technologies (eg treatment of diseases) • Competitiveness & sustainable development technologies (eg food technologies) • Emerging & interdisciplinary areas	• High speed reliable information systems (eg mobile internet) • Next generation ICT (eg human interface technology) • R&D infrastructure (eg databases) • Human resource development (eg software)	• Global warming • Zero waste & recycling • Riparian areas & urban renewal • Chemicals risk management • Global water cycle • Intellectual infrastructure (eg biological resources)	• Nano-devices (eg next generation ICT) • Materials for environmental and advanced energy applications • Ultra -small medical systems (eg nano-biology) • Basic technologies (eg measurement) • Materials with innovative properties
Five-year objectives	***Five-year objectives***	***Five-year objectives***	***Five-year objectives***
• Realising healthy secure lives • Developing advanced technologies with industrial and environmental applications • Promotion of interdisciplinary research (eg bio-informatics)	• Implementation of high speed reliable ICT (eg wireless broadband) • Developing next generation ICT • Improving R&D infrastructure (eg supercomputer networks)	• Addressing global warming • Moving to zero waste • Improving environmental amenity • Better management of chemicals and water • Improved environmental research	• Nono-devices for next generation ICT systems • New materials • New ultra-small medical devices • Improved measurement technologies
Promotion measures	***Promotion measures***	***Promotion measures***	***Promotion measures***
• Strengthen national effort • Improve collaboration • R&D Centres	• Promote R&D and strengthen collaboration • Increase researcher mobility • Investigate societal impacts	• Improve R&D quality • Increase resources for research	• Encourage competition for R&D funds • Promote co-operation • Improve researcher-user links • Build human capital

Source: The Allen Consulting Group based on JSTC, 2002, Table 3.1.4.

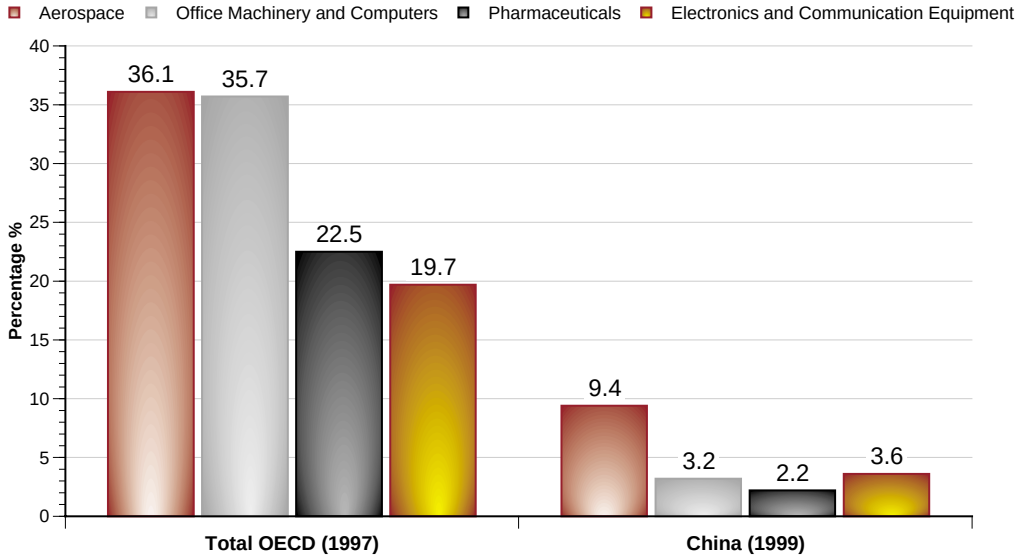
At both the highest level (Life sciences, ICT, the Environment, nanotechnology and materials) as well as at the disaggregated level, Japan's research priorities map well against Australia's National Research Priorities. However in order to be seen a serious partner and to gain significant benefits from S&T cooperation with Japan, Australia needs to be able to be seen to be willing to provide larger amounts of funding for S&T projects with Japan.

6.2 China

China's R&D intensity in high technology sectors is low by comparison with OECD country averages (see Figure 6.1). In 1999 GERD as a percentage of GDP was 0.41 per cent. China's S&T capabilities are, however, growing rapidly.

Figure 6.1

R&D INTENSITY IN HIGH-TECHNOLOGY SECTORS (AS % OF SECTORAL VALUE-ADDED)



Source: OECD, 2002, *OECD Science, Technology and Industry Outlook 20023.6*, Paris

Key Agencies

The Ministry of Science and Technology is responsible for strategic planning as well as basic research and other S&T Programs. Other key bodies involved in S&T include the Ministry of Education, the Chinese Academy of Science and provincial governments.

International S&T Activity

China's policies in relation to international S&T co-operation during the current Plan emphasise a focus on priorities, mutual benefits and coordination. China is improving policies, laws and regulations for international S&T co-operation, increasing the level of international co-operation activity and strengthening the administration of international S&T co-operation and the management of intellectual property rights.

Most OECD countries have S&T cooperation arrangements with China. US–China cooperation has been strong for more than a decade. At a meeting between the US and China in April 2002, it was decided that priority areas for future S&T cooperation would be: Agricultural Science and Technology; Clean Energy; Nanotechnology; Global Change; Genomics; Science Education; and Information Technology.

Japan and Korea both have cooperation programs with China. Japanese cooperation has emphasised environmental research. In the late 1990s Japan invested more than $US100 million in the construction of an environmental research centre in Beijing.

EU-China cooperation in S&T started in the early 1980s, and has increased since the 4th Framework Programme for Research and Technological Development (1994). The main instrument has been the EU's programme for Scientific and Technological Cooperation with Developing Countries. Up to 2002 more than 100 EU projects included Chinese partners, and China has been one of the most active cooperation partners among non-member states.

In 2001 the number of new projects in the programme increased to 33, including 19 new projects with a total budget of approximately $A31 million[33], and 14 new projects in the thematic programmes with a total budget of $A40 million. Chinese researchers have been particularly successful in accessing projects the areas of IT, life sciences, energy and materials research.

Australia's S&T cooperation with China is at a low level. Very limited dedicated (generally available) funds are available through DEST's China Fund – part of the IAP-IST Programme. ARC grant recipients and the CSIRO account for a larger number of cooperation activities. Some Australian universities have campuses in China or other links, but the emphasis is on education rather than S&T.

China's National S&T Priorities

China is currently midway through its Tenth Five-year Plan (2001-5).[34] In the context of this Plan, China operates a number of S&T programs. These give an indication of China's national S&T priorities.

National High Tech R&D Program ('863 Program')

This Program aims to strengthen high technology innovation capacity, especially in strategic fields and where China has relative advantages. In the current Plan period, this Program's general priorities are key technologies:

- information infrastructure;
- agricultural and medicinal technologies; and
- new materials and advanced manufacturing.

In addition, projects in six high technology fields (information technology, biological and modern agricultural technology, new material, advanced manufacturing and automation, energy and resources and the environment) are being supported.

National Key Technologies R&D Program

With a strong focus on economic and social development, this Program has similar priorities to the 863 Program, but appears targeted at cooperative research between universities, research institutes and industry.

Basic Research Program ('973 Program')

Operated by the National Natural Science Foundation, this Program currently has a sustainable development theme in agriculture, energy, information, resources and environment, population and health, and materials. In this context, it emphasises life sciences, nanoscience, information and earth science.

Research and Development Capacity Building

Under this Program, China is investing in government laboratories, national megascience projects, national engineering research centres and major international S&T projects. New national megascience projects in the current Plan include an accelerator, a telescope and a continental drilling project. International projects include space science and high-energy physics.

---

[33] The exchange rate used in this report is € 1.0 = $A1.81.

[34] Ministry of Science and Technology, 2001, *China's Major Science and Technology Programs 2001-2005*.

S&T Industrialisation Environment Construction

This Program emphasises technology diffusion and application. It supports the development of technology parks and incubators as well as direct transfer of technology to users.

Major dedicated National S&T Projects

Twelve projects are being supported under the present Plan. They include Super large-scale integrated circuits and software, information security and E-commerce, functional genomics and bio-chips, electric cars, high speed magnetic suspension transport, medicine (including development of traditional Chinese medicine), agriculture processing technology, food security, water-efficient agriculture, water pollution control and technical standards.

6.3 Korea

Key Agencies — Roles and Priorities

In 1999, GERD as a proportion of GDP in Korea was 2.47 per cent. The Ministry of Science and Technology (MOST) is the central Korean agency responsible for overseeing national S&T policy[35]. It administers S&T affairs and coordinates national R&D programs. The main functions of MOST include:

- formulation of policies for S&T development;
- technology forecasting;
- development of technology;
- pursuit of technological self-reliance for the safe use of nuclear technology;
- support for research conducted by government research laboratories, universities, and private research institutes;
- policy formulation for R&D investment, human resources development, S&T information, and international S&T cooperation; and
- promotion of public awareness of S&T

MOST coordinates S&T policy among the ministries. In addition, MOST reviews and coordinates national S&T policies and R&D programs.

Priorities for the allocation of S&T funds are set by the National Science and Technology Council, which is chaired by the President. It is composed of ministers of S&T-related ministries and representatives from the S&T community. MOST serves as the secretariat for the NSTC. In addition, the Presidential Council on Science and Technology reviews science and technology policies and provides advice on related matters.

The Korean Science and Engineering Foundation (KOSEF) was established in 1977 to increase national S&T through research, promotion of science education and international cooperation with other countries.[36] KOSEF is a government funded non-profit organisation.

[35] See http://was.most.go.kr/most/english/Index.jsp

[36] This section draws on KOSEF's, Annual Report 2001.

International S&T Activity

Until recently, Korea's S&T cooperation with foreign partners was focussed on the acquisition of technology. Partnerships were limited to advanced countries, particularly the US, Japan, and several European countries. Korea is now taking a different approach to international cooperation, and is seeking a more active role in the international science and technology community, not only to contribute to scientific advancement but also to harness new knowledge for the nation's social and economic development. To this end, it is actively pursuing both bilateral and multilateral cooperation.

KOSEF lists international cooperative arrangements with 45 organisations in 30 countries[37] including the AAS, ARC and ATSE in Australia and the NSF in the US, the Natural Science and Engineering Council in Canada, UK Royal Society and the Japan Society for the Promotion of Science. KOSEF's latest available data on cooperation activities is shown in Figures 6.2 and 6.3. Figure 6.2 indicates a relatively even distribution of international joint research grants across research fields, with the highest proportion of grants going to chemistry and Materials and Resources (both with 13 per cent of all grants. Figure 6.3 indicates that Chemistry was the field with the highest representation of joint seminars by field with 24 per cent of all seminars.

MOST's International Joint Research Program, started in 1985, has been the source of support for international projects initiated through bilateral agreements between researchers or institutions. Up to 2000, the Korean Government supported more than 1,436 joint projects through the program.

The major partner countries have been the US, the UK, Japan, China, Germany, and Russia. Recently, the scope of partners has diversified considerably - in particular cooperation with Eastern Europe has increased.

In general, bilateral cooperation with foreign countries is based on an inter-governmental S&T cooperation agreement. The joint research projects agreed on at bilateral meetings have been implemented mainly through the International Joint Research Programs.

A brief description of Korean international S&T activities with a sample of countries is provided below.

United States of America

Following the conclusion of the Korea–US Agreement on S&T cooperation in 1976, a wide range of joint research projects as well as exchanges of scientists and engineers have been undertaken. The agreement, amended in 1993 and 1999, prescribes the allocation of intellectual property rights (IPR's) and strengthens its protection. The Korea-US Joint Committee on S&T meets every two years.

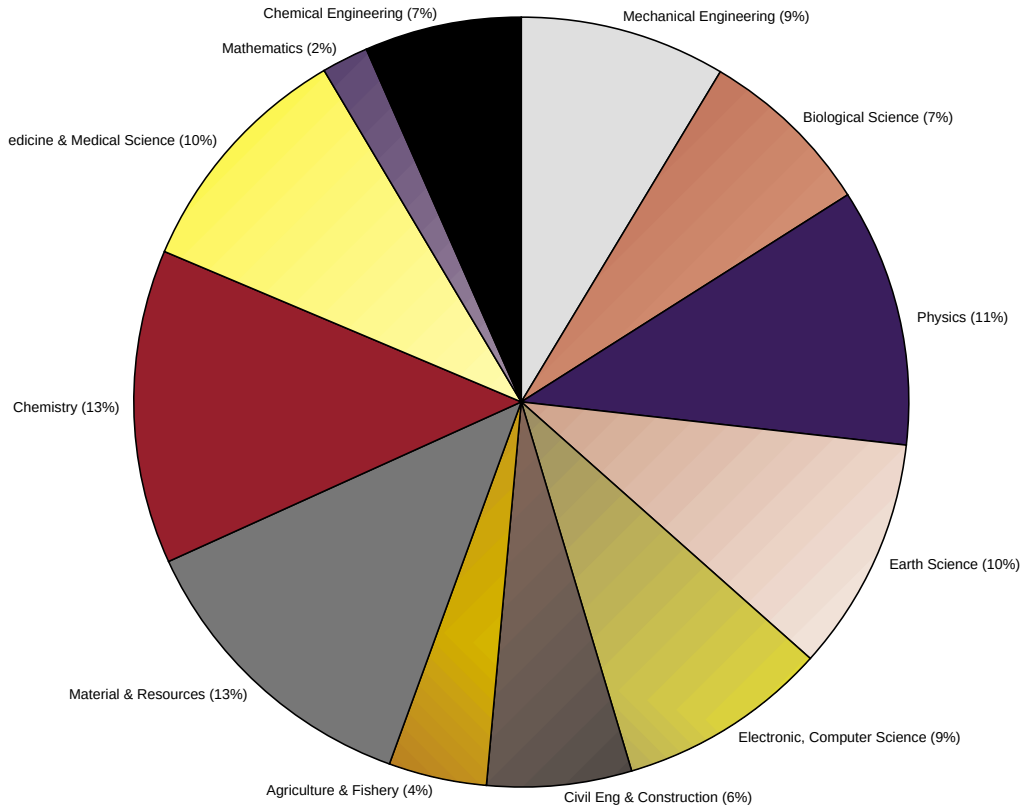
United Kingdom

S&T cooperation between Korea and the UK has been fostered by the Korea-United Kingdom S&T Cooperation Agreement of 1985. Annual Korea-UK Round Table Meetings on S&T cooperation help to the promote S&T cooperation. As a result of these meetings, the Korea-UK Joint Research Fund Program, the KIMM-Rolls Royce Collaborative Research Project, and the S&T Joint Scholarship Program have been established.

[37] See http://www.kosef/re/kr accessed on 21 July 2003

Figure 6.2

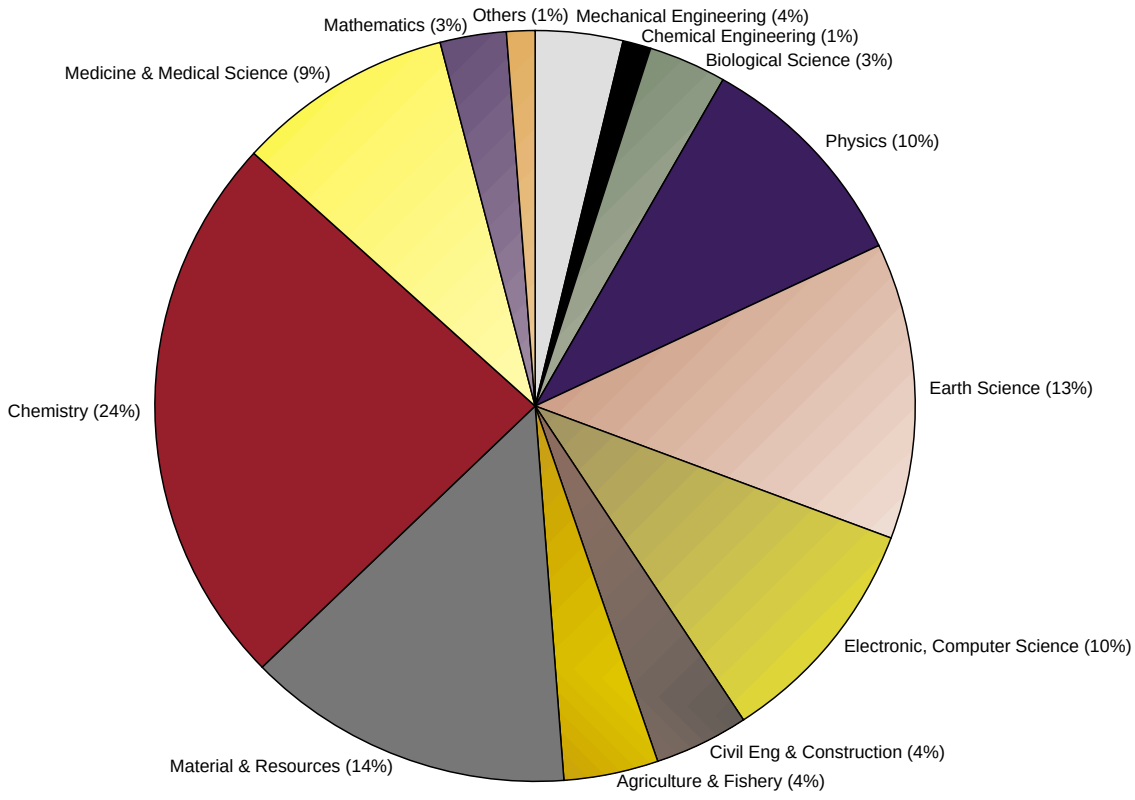
INTERNATIONAL JOINT RESEARCH GRANTS BY FIELD (1999)



Source: KOSEF, 2000

Figure 6.3

INTERNATIONAL JOINT SEMINARS BY FIELD (1999)



Source: KOSEF, 2000

Japan

Since the Korea-Japan S&T Cooperation Agreement was signed in 1985 the Korea-Japan Committee on S&T Cooperation has met annually. A wide range of joint research projects as well as exchange of scientists and engineers have been carried out. Korea and Japan Science and Technology Fora have laid the groundwork for recent cooperation. In addition, the Korea-Japan Joint Committee for Basic Scientific Research, which meets annually, has played an important role in promoting bilateral cooperation in basic science. Province-to-province S&T cooperation programs between the two countries are also active.

China

S&T cooperation with China has been carried out under the provision of the Korea-China S&T Cooperation Agreement signed in 1992. A variety of cooperative activities such as the exchange of technology survey teams, post-doctoral training programs, joint research projects and others have been undertaken.

Germany

S&T cooperation with Germany takes place under the Korea-Germany S&T Cooperation Agreement concluded in 1986. Cooperation activities have taken place in fields such as new materials, laser technology, and automation. In order to strengthen cooperation between the private sectors of the two countries, Korea and Germany have established the Korea-German Non-Governmental Committee on Science and Technology.

Russia

Since Korea and Russia signed the Korea-Russia S&T Cooperation Agreement in December 1990, S&T cooperation between the two countries has been actively promoted through the exchange of scientists and joint research projects. In addition joint research centres have been established in such areas as aerospace, materials, energy, and optics.

EU

Korea and the EU concluded an Arrangement on S&T Cooperation in 1992. Joint S&T Seminars have been held and scientists and students have been exchanged.

Korea is also a participant in the International Science and Technology Centre, which promotes the non-proliferation of weapons technology of mass destruction. The Centre coordinates the efforts of numerous governments, international organisations, and private sector industries to provide weapons scientists from Commonwealth of Independent States countries with opportunities to redirect their talents to peaceful science.

Australia

The only generally available support for S&T cooperation with Korea is through a small bilateral fund – part of DEST's IAP-IST Programme. ARC grant recipients account for the largest part of Australian S&T cooperation with Korea. The Academy of Technological Science and Engineering, with support from DEST, has played an important role in building cooperation with Korea in Frontier Technology areas. However, given Korea's advanced industrial performance, Australian S&T cooperation with Korea is very low.

Korea's National S&T Priorities

The current five-year Plan for S&T Innovation (2002-6) was announced in 2001 to improve national S&T competitiveness. The five year Plan implements the first stage of Vision 2025 (see below). Key aspects of the Five-year Plan for S&T Innovation involve:

- increasing government expenditures on R&D;
- increasing basic research as a percentage of total government R&D budget; and
- increasing R&D manpower.

Korea's S&T policy is now directed toward national development, concentrating on meeting social needs, and harmonising human activities and the environment. This is in contrast to the previous policy, which emphasised industrialisation.

The Korean government launched a long-term strategic initiative, the Long-term Vision for Science and Technology Development toward 2025 (Vision 2025) in September 1999. Vision 2025 aims to secure future economic growth through the development of science and technology. The goals are grouped in three time frames spanning a 25-year period.

- First Step (by 2005) — place the Korean S&T capabilities at competitive levels with those of the world leading countries by mobilising resources, expanding infrastructure, and improving relevant laws and regulations.
- Second Step (by 2015) — stand out as a major R&D promoting country in the Asia-Pacific region, actively engaging in scientific studies and creating a new atmosphere conducive to the promotion of R&D.
- Third Step (by 2025) — secure a scientific and technological competitiveness in selected areas comparable to those of G-7 countries.

The plan has several major features including shifting Korea's innovation system's focus from government-led to private sector-led, improving the effectiveness of national R&D investment, realigning Korea's R&D system from a domestic to a global network and addressing information technology and biotechnology opportunities.

6.4 Conclusions

For Japan, China and Korea, bilateral S&T agreements are a prerequisite to international S&T cooperation.

Japan

Japan has a very strong S&T system and Australian researchers have established strong working relationships with Japanese counterparts in a number of areas. Australia's participation in the Photon Factory at Tsukuba has contributed to this relationship. Widespread use of English in research laboratories, and the ability of some Australian researchers to speak Japanese have made cooperation easier. The fact that Japan is in roughly the same time zone as Australia also makes S&T cooperation with Japan easier than with other leading industrialised countries.

There is a good match between most of Australia's National Research Priorities and those of Japan. Japan's strong track record in the application of leading edge science and technology, coupled with its growing strength in basis research make Japan an excellent S&T partner for Australia.

Japan has a number of mechanisms for supporting a wide range of international S&T activities, including support for early career researchers. Australia is not taking full advantage of some of these programs which support foreign researchers. The Australia science counsellor in Tokyo should be tasked to address this issue.

All of Japan's S&T priorities are of interest to Australia. Australia's ability to contribute in the most advanced sub-fields of ICT was perceived by Japan to be somewhat limited during the 1990s. Australia's new National ICT Centre of Excellence should help to overcome this.

Japan offers excellent opportunities for Australia in S&T cooperation. However, Japan is not likely to see Australia as a serious S&T partner without a significant increase in Australian funds available for S&T cooperation.

China

There are a number of factors that contribute to the current research priorities in China. Among them are:

- the need for increased agricultural production, raising the incomes of farmers, and food security;
- the need to reduce reliance on coal and develop alternate sources of energy production, promote clean coal technology, and improve energy efficiency;
- the need to reduce widespread pollution and its effects; the need to clean up the environment; and
- water shortages.

China's priority areas of research therefore include agriculture, automation, biology and biotechnology, energy, environmental science, hazard reduction & control, information technology, materials science, marine science, mineral resources & exploration, pharmaceuticals, population control and health, sustainable development, water resources. There is also a strong focus on commercialisation, industrialisation, and new industries, particularly high-tech industries.

Australia has particular strengths in agriculture, energy, environmental science, marine science, medical science, and mineral resources and exploration. Thus there are good opportunities for collaborative activities in these areas that result in mutual benefit.

The barriers to S&T cooperation with China include language and concerns in some areas regarding intellectual property rights. The availability of funding for Australian researchers wishing to participate in S&T cooperation with China through the bilateral agreement falls well short of what is needed for Australia to take advantage of the opportunities available, and to position its future relationship with this superpower.

Korea

Language barriers, lack of funding for Australian researchers and concerns about intellectual property management are the major factors limiting Australian S&T cooperation with Korea.

Korea provides a range of mechanisms to support a wide range of international S&T cooperation activities. Korea's strong industrial base and its high level of investment in R&D make it an attractive partner for Australian researchers

Korea is a very strong performer in a number of Australia's priority areas especially Frontier Technologies and, as indicated in this analysis, Korea is now giving increasing attention to Australia's other three National Research Priority areas.

While Korea is willing to make significant investments in international S&T cooperation and some Australian researchers are not daunted by the language barriers, the funding available through DEST's IAP-IST Programme is insufficient to support more than a few of the high quality proposals which the Program receives.

On the basis of the analysis in this study and noting the efforts of other OECD countries to build stronger links with Korea, more intensive effort and support for Australia international S&T cooperation with Korea would be justified.

Chapter Seven

Other Countries – International Linkages

Three other countries are of interest to this study — Switzerland because it is a non-EU European country; Canada because of its similarities with Australia; and New Zealand because it, like Australia, is distant from other industrialised countries.

7.1 Switzerland

The Swiss National Science Foundation (SNF) aims with its research programmes to 'make a positive contribution to scientific research in the relevant areas of the world and to promote research cooperation between these areas and Switzerland'.

The SNF strengthens scientific cooperation at an international level through:

- promotion of exchanges of individual scientists;
- funding of seminars for exploring new areas of cooperation between researchers from Switzerland and selected partner countries; and
- support for international research projects and other measures with selected regions (particularly Eastern Europe).

Examples of SNF international programs are provided below.

SCOPES 2000 - 2003

This Program, with a budget of SF14 million[38] ($A15.7 million) supports international S&T with eighteen countries in Eastern Europe. The Program aims to build research capacity, strengthen institutions, promote networking and mobility and help research funding agencies that use peer review. The Program contains five different activities.

- Conference Grants to enable scientists from the partner countries to participate in international scientific conferences in Switzerland (annual budget $A448,000).
- Preparatory Grants which assist the development of proposals for joint research projects and institutional partnerships.
- Joint research projects to enable scientists from the partner countries to undertake research projects with Swiss scientists. Funding of up to $A67,000 per project, 80 per cent of which must benefit the Eastern European partner(s).
- Institutional partnerships, which contribute to the further development and modernisation of institutional aspects of research and higher education. Eligible activities include restructuring of research institutions; renewal and/or expansion of infrastructure, etc. Funding of up to $A118,000 per grant.
- Cooperation with funding agencies in the partner countries in order to strengthen research funding agencies in the partner countries

[38] The exchange rate used is SF1 = $A1.12.

Switzerland–Japan Scientific Seminar Program

The SNF, in cooperation with the Japan Society for the Promotion of Science (JSPS) supports proposals for joint Swiss-Japanese scientific seminars to be held either in Switzerland or in Japan. These seminars strengthen ties between Swiss and Japanese scientists and help to generate new scientific cooperation between the two countries. The SNF and the JSPS select up to three seminars for support from proposals received. Switzerland has a similar program with Korea.

EUROCORES Self-Organised Nano-Structures (SONS)

The European Science Foundation has launched a nineteen country European network for fundamental research in this area of nanotechnology. The Swiss National Science Foundation has decided to contribute to EUROCORES SONS and finances the participation of Swiss researchers.

7.2 Canada

Canada has a range of research support programs at Federal and Provincial levels, and many of which have the flexibility to support the international aspects of research projects and international exchanges of research personnel. Canada is a federal country with a science and innovation system that is similar to Australia's.

An Expert Panel report[39] prepared for Advisory Council on S&T (ACST) concluded that Canada's international S&T was lacking:

- a coherent policy framework for international S&T;
- an efficient mechanism for coordination of these activities; and
- appropriate investment mechanisms.

The ACST report made recommendations in the areas of Science, Technology and Government Policy.

Science

The Panel recommended that the Federal Government create a special fund to encourage the scientific community to foster international cooperation. This fund would be accessible to the academic, government and the private sector. The fund is not intended to replace core funding in government departments and agencies.

The fund should provide additional support, when needed and on a competitive basis, for the following:

- international partnerships and collaborative research, including multi-sector partnerships;
- Canada's participation in international programs;
- Canada's access to international facilities;
- Canada's participation in international S&T organisations; and
- Canadian participation in activities under bilateral and multilateral government-to-government S&T agreements.

[39] ACST, 2000

The Panel believed that the fund would enhance Canadian participation in key international endeavours, ensure its continuity when appropriate and, as a result, restore the visibility and credibility of Canada on the international S&T scene.

Technology

Given the importance of SMEs in the Canadian economy, the Panel recommended that a new mandate with additional resources be given to the Industrial Research Assistance Program of the National Research Council Canada (IRAP/NRC) to support the international S&T endeavours of Canadian SMEs.

Under this new mandate, and in cooperation with the Department of Foreign Affairs and International Trade (DFAIT) and guided by an Executive Committee, IRAP/NRC should:

- gather and analyse strategic technology intelligence and funding opportunities on the international scene;
- access and assess technologies developed abroad, through visits, technology missions, networking, and partnering events; and
- through these activities, support SMEs in setting up international technology-based ventures to enhance their development.

Government Policy

The Panel emphasised the importance of including S&T in Canada's foreign policy and recommended that:

- responsibility for international S&T should be assumed by an Executive Committee to be chaired jointly by DFAIT's Deputy Minister, International Trade and Industry Canada's Deputy Minister;
- membership of this executive committee include major S&T stakeholders and the heads of the organisations that will manage the new funds for international activities; and
- this Committee be responsible for defining Canada's international S&T policy and coordinating Canadian decentralised international S&T activities.
- In key countries, DFAIT heads of mission should be specifically charged with the delivery of the S&T program.

The Panel also recommended that the Executive Committee be responsible for defining the number, the selection criteria, tasking, geographic location, and re-allocation of DFAIT's S&T counsellors and technology development officers.

One contribution to the ACST report[40] analysed a number of developed countries' approaches to international S&T policy. It considered whether countries have in place explicit international S&T policies and the strategies that the countries employ to further their international S&T objectives. Table 7.1 sets out some of the findings.

While there was no official government response to the ACST report, there have been a number of new initiatives by the government to support Canada's international S&T effort. These have included increased funding for the Canadian Foundation for Innovation, the expansion of the National Research Council Industrial Research

[40] Voyer, R., 2000

Assistance Program funding for small and medium sized enterprises (SMEs) and a new strategic alliances office with the role of enhancing the government's abilities to assist Canadian SMEs in developing international collaboration.[41] These changes are reflected in the support for international S&T are listed below.

Table 7.1

INTERNATIONAL S&T GOALS, OBJECTIVES AND STRATEGIES: YEAR 2000

Country	*Key Strategies*
Australia	Bilateral and multilateral agreements Research collaboration Access to international facilities S&T Counsellor network
Canada	Bilateral and multilateral agreements S&T Counsellor network Participation in international programs
France	Bilateral and multilateral agreements Participation in EU Framework Programs Participation in international programs Research collaboration S&T Counsellor network
Germany	Bilateral and multilateral agreements Participation in EU Framework Programs R&D institutes abroad S&T Counsellor network
Japan	Bilateral and multilateral agreements Initiation of international programs Research collaboration Exchange of researchers S&T Counsellor network
Sweden	Bilateral and multilateral agreements Participation in EU Programs S&T Counsellor network
United Kingdom	Bilateral and multilateral agreements Access to international facilities Individual research collaboration Participation in EU Programs S&T Counsellor network
United States	Bilateral regional and multilateral agreements Access to international facilities Research collaboration Agency offices abroad S&T Counsellor network
European Union	Framework program activities Bilateral agreements with third countries

Source: Voyer, R, (2000), *International S&T Strategies: An International Comparison*, prepared for the ACST Expert Panel on Canada's Role in International S&T

[41] http://infoexport.gc.ca/science/fndgeneral-en.htm.

Programs Supporting International S&T Activity

The following descriptions cover some Canadian programs that support international S&T. The Canadian National Science, Engineering Research Council (NSERC) is the most important agency in promoting international S&T.

NSERC recognises that leading-edge research developments now occur globally, and researchers must be able to work with their international colleagues to capitalise on and contribute to advances in science and technology. To address this need, NSERC is extending the scope of its programs to provide Canadian academic researchers with even more access to international expertise and technical resources.

NSERC - Special Research Opportunity Program

Recently established (January 2003) the Special Research Opportunity (SRO) Program provides a mechanism for supporting research breakthroughs and high-risk research. These grants will enable researchers to pursue new and emerging research opportunities as they become apparent, and investigate and develop the new collaborations in Canada or abroad that will enable them to respond to these opportunities.

What distinguishes this new Program will be its ability to respond quickly to new opportunities international opportunities, and to accelerate time-sensitive research.

NSERC — Collaborative Research Opportunity Grants

This Program currently provides grants to cover research costs of special international collaborative opportunities. Grants support groups of researchers from Canadian and foreign institutions, showing evidence of collaboration and prospective interdependence. These grants are awarded on a competitive basis for special opportunities that arise and depend on a well-timed response. They also require an international team effort and that could not be funded from other NSERC programs. The Program budget is $A6.5m in 2002-3, and projects normally had to exceed $A109,000[42]. This program is to be phased out and replaced by the new Special Research Opportunity Program

NSERC — International Opportunity Fund

This Program, which is also being replaced by the Special Research Opportunity Program, supported researchers at Canadian universities for travel, workshops, symposia and other start-up administrative costs. The program supported the development of collaborative research opportunities, rather than the research itself. Its budget was $A1.1m per year.

NSERC/IRAP Assistance to University Researchers and SMEs

This is an initiative with the National Research Council's Industrial Research Assistance Program (IRAP) to provide grants to enable university researchers and small-and medium-sized Canadian enterprises to jointly participate in international projects. This Program facilitates the participation of Canadian industry and university researchers in international projects such as the EU's Sixth Framework Program.

[42] The exchange rate used is $C1 = $A1.09.

NRC - Technology Inflow Program

The Technology Inflow Program of the National Research Council (NRC) funds Canadian companies with less than 500 employees for travel costs associated with the acquisition of foreign technology and formation of strategic R&D partnerships. Canada's Science and Technology Counsellors, Trade Commissioner Service Officers and NRC's IRAP Industrial Technology Advisors assist companies to locate foreign technology and potential foreign R&D partners. Funding is provided on a competitive, cost-shared basis.

The Department of Foreign Affairs and International Trade Going Global S&T Fund

As part of its International S&T Program, Department of Foreign Affairs and International Trade manages the Going Global Fund, which assists Canadian researchers in the first stages of relationship formation and mutual exploration for the purposes of new international collaborative R&D initiatives with foreign partners. Up to 50 per cent of eligible expenses to a total of $50,000 is awarded to groups on a competitive basis.

NATO Science Fellowships

Non-Canadian scientists and engineers from NATO partner states are eligible for support to undertake research in the natural sciences or engineering. Preference is given to emerging rather than established researchers. The fellowships provide an annual stipend of $A30,500 and cover the costs of relocation. The host institution will provide an additional $A5,500. The objective of this program is to allow emerging scientists and engineers from NATO Partner countries to pursue postdoctoral research in the natural sciences and engineering at Canadian universities.

Country Specific Programs

There are also a number of programs which target collaborative activities with specific countries, including:

- *British Chevening/Athlone-Vanier Engineering Fellowship Supplement* — an initiative which provides assistance to graduate engineering students who have been accepted in a graduate-engineering program of studies in the UK.
- *Canada-United Kingdom Millennium Research Awards* — assisting researchers who have been awarded an NSERC Postdoctoral Fellowship, and are going to take up the award in the UK with relocation costs and living expenses.
- *Canada-Israel Industrial Research & Development Foundation* — an initiative assisting SMEs in both countries to find potential partners for joint research projects for the further development of their innovations.
- *Canada-France Cooperation* — an agreement between the two countries supports technology missions and other joint initiatives. To advance this initiative, IRAP and ANVAR have initiated and now completed an exchange of personnel.

7.3 New Zealand

While New Zealand is a much smaller country than Australia with less expenditure on R&D as a percentage of GDP, it faces similar challenges to Australia in seeking to establish S&T cooperation with distant industrialised countries.

The Ministry for Research, Science and Technology (MoRST) takes the view that New Zealand's future well-being is critically dependent on the effectiveness of its science and innovation system. Because less than 0.2 per cent of the world's R&D activity occurs in New Zealand, it has much to gain through international scientific collaborations.

MoRST supports inward and outward research co-investment and technology transfer in order to provide access to overseas research facilities and to equipment not currently available in New Zealand. It endeavours to ensure:

- greater connection between New Zealand's public and private S&T sectors and the rest of the world;
- effective co-ordination and policy alignment among key government departments, particularly between the MRST and the Ministry of Foreign Affairs and Trade; and
- that New Zealand's International obligations within multilateral fora are met and NZ benefits from its participation within such fora.

Funding opportunities for international linkages provided by the MRST include overseas travel; collaborative research; and fellowships and international awards.

International Science and Technology Linkages Fund

The International Science and Technology (ISAT) Linkages Fund was established in 1994. The Fund supports commitments to treaties or treaty level international agreements, international S&T activities to support New Zealand's recognised strategic interests overseas, and leadership/leverage of new international science and technology initiatives. The purpose of the Fund is to ensure that New Zealand S&T activities achieve full integration with the best international research and development effort.

Its objectives are to:

- develop international opportunities and utilise overseas advances in research, science and technology (RST) for economic, social and environmental progress;
- positively influence regional and international RS&T linked activities that advance New Zealand's national interest;
- increase the level of funding, scientific skills and technological capabilities that New Zealand is able to source from other countries; and
- promote international recognition of New Zealand as a centre for innovation.

The Royal Society of New Zealand administers the first two ISAT sub-programs listed, while the third is administered by MoRST itself.

Contestable Bilateral Research Programs

The Contestable Bilateral Research Programs (covering bilateral research programs and S&T cooperation agreements) support the development and enhancement of research relationships with other countries with an emphasis on supporting new activities and relationships.

Funding has been specifically dedicated to research collaborations involving Australia, France, Germany, Japan, Korea, Latin America, the US, and the UK, but funding for research collaborations with other countries is also available. The Programs facilitate bilateral research through the provision of funding for New Zealand researchers to travel overseas or for overseas researchers to travel to New Zealand to work on joint research projects. Applications normally seek up to $NZ5,000 per annum.

Overseas Travel

Funding opportunities to allow New Zealand researchers to travel overseas for international conferences or meetings are provided through the Technical Participation Program. This Program aims to support the participation of New Zealand researchers at international conferences or meetings, of policy significance to New Zealand.

France/New Zealand Cultural Agreement

The 1977 France/New Zealand Cultural Agreement supports projects on environment, agriculture, forestry, chemistry, physics and geology. Funding is provided on a yearly basis, but projects may receive support for 2-5 years. Funding is not restricted and may cover items such as internal travel and living expenses in France (or New Zealand in the case of a French candidate) and grants for laboratory works, etc. Projects are funded on a reciprocal basis, each country contributing approximately 50 per cent of the cost. The French Ministry of Foreign Affairs finances about 20 per cent of the total budget.

7.4 Conclusions

Switzerland, Canada and New Zealand all spend significant resources on assisting international S&T cooperation. These countries offer a variety of measures targeting different researcher groups and supporting different types of international S&T activities.

Each of these countries provides multiple measures, including generally available programs to assist international S&T. These countries support a range of international S&T activities. They also recognise the need for flexibility and rapid response to new international S&T opportunities as and when they arise.

Canada has identified the need for better coordination of international S&T support arrangements and activities. Coordination is less of an issue for New Zealand and Switzerland. Canada and Switzerland both place importance on science counsellors in other countries.

Chapter Eight

International S&T – Benefits and Analysis

This Chapter brings together the two major elements of this study, the review of international S&T initiatives in a sample of countries and the exercise of mapping Commonwealth international S&T. It reviews what has been learnt about international S&T and implications from this study's findings.

International S&T is complex, comprised of many different activities that are difficult to characterise and with benefits that are difficult to measure. The long-term economic and social benefits derived from these activities have been well articulated in the literature and are not in question. The major issue currently being faced in regard to international S&T in Australia, and indeed across the world, is how such activities can best be managed and supported.

An obvious tension exists between what is a diverse group of activities and the need to develop a comprehensive policy framework for their support. Such a policy framework needs to be strategic, focused upon national priorities and retention of national benefits, while concurrently allowing for a high degree of flexibility such that the potential to form valuable new collaborations and partnerships is encouraged and enhanced.

The issues outlined above are addressed in this Chapter in the following way:

- Section 8.1 summarises the economic value of investment in international S&T;
- Section 8.2 reviews the rationale for investment in international S&T;
- Section 8.3 summarises Australia's need for international S&T collaboration;
- Section 8.4 maps the nature and scope of Commonwealth international S&T activities;
- Section 8.5 summarises the role of bilateral and multilateral S&T agreements;
- Section 8.6 discusses the relationship between national and international S&T priorities;
- Section 8.7 provides an analysis of international S&T policy and best practices, drawing upon the literature-based review of other countries in Chapters 4 to 7; and
- Section 8.8 provides directions for further work.

8.1 Economic Value of International S&T Collaboration

As discussed throughout this study, the development of new ideas and knowledge, such as that undertaken in S&T activities, can contribute to a nation's economic progress and productivity growth. In traditional models of economic growth (known as neoclassical growth models), the accumulation of capital (for example, machinery and equipment) is the main driver of growth, with long run growth set at the rate of technical progress, a factor determined outside the model. New growth theory models of economies challenge this view. The new models, also known as endogenous growth models, differ from neoclassical growth models by assuming that factors within the production process, such as growth in human capital and knowledge, can determine the long-run growth rate.

Particular characteristics of the development of new ideas and knowledge can drive economic growth. Dowrick's[43] research has illustrated this process. Specifically, he points to the development of what he calls 'disembodied human capital' — the realm of knowledge and ideas that do not live and die with their inventors but can be transmitted freely between people and carried forward over generations. A crucial economic attribute of disembodied human capital, highlighted in recent models of endogenous economic growth, is that ideas are both non-rival and cumulative. Non-rivalry implies that once an idea has been announced, people can simultaneously use this idea, further develop it and apply it to a range of applications. One person's use of the idea does not prevent another person from using it at the same time. Moreover, ideas are cumulative, for example, the idea of electronic computing has led to the idea of quantum computing, which may in turn lead to yet further ideas.

Analysis of these attributes of non-rivalry and cumulative feedback has led growth theorists to speculate that investment in the generation of ideas can be the engine of long-run growth. However, the non-rivalry of knowledge also leads us to expect market failure. When others reap the benefits of someone's new ideas, market forces alone are unlikely to generate enough investment in knowledge. Hence, there is a danger that too little knowledge will be generated without the optimal level of Government subsidisation.

These benefits from the development of ideas and knowledge, through R&D and science and technology activities, also apply to activities undertaken internationally. A recent study by the OECD found that a 1 per cent increase in the level of foreign R&D generates on average a 0.44 per cent increase in productivity growth in a national economy.[44] This reflects the fact that technology spills over across borders, and that any nation is highly dependent on others for improving its productive efficiency.

[43] Dowrick, S. 2002, *Investing in the Knowledge Economy; implications for Australian economic growth*, p. 3.

[44] OECD, 2001, *R&D and Productivity Growth: panel data analysis of 16 OECD counties*, STI Working Paper 2001/3.

The OECD study also emphasises that for a country to take full advantage of foreign R&D, it must also actively invest in its own R&D activities. The 'free rider' approach does not work because, in order to benefit from foreign R&D, a country must have the domestic capacity to not only access, but also absorb and adapt the foreign R&D. Such capacity is only developed through a country undertaking its own R&D activities, and, further, undertaking collaboration on research projects with international partners. A further advantage of collaboration activities is that they give national researchers access to large projects and facilities, which might not have been funded domestically due to their size.

Thus international S&T collaborative activities become the vital link that connects our efforts with those of the rest of the world. To be able to act as an effective 'receptor' we need to be undertaking quality research in order to attract interest from potential overseas partners.

8.2 Rationale for Supporting International S&T

This study has provided an overview of S&T policies in other countries, a review of the economic benefits of international S&T collaborations and a first mapping of the characteristics of international S&T collaborations undertaken by the Commonwealth. In this section, the 'lessons learnt' are drawn together in support of the recommendations which follow in Chapter 9.

A major study[45] into Canada's approach to international S&T highlighted reasons why effective international S&T collaboration is important to researchers, companies and government. It suggested that:

- researchers need to collaborate and exchange scientific information with researchers in other countries in order to stay abreast of the latest scientific development, gain access to the best equipment, facilities and talent, and to participate in large-scale research projects that are beyond the ability of individual countries to finance alone;
- companies need to be able to acquire information regarding new technologies from around the world – both for the purposes of competitive intelligence and for use in developing their own new products and services — and to carry out R&D activities with the best possible partners; and
- governments need to participate in and contribute to international S&T forums in order to be well informed in order to make good decisions regarding science based issues and to develop appropriate scientific protocols, codes and standards. (It could also be argued that participation in international S&T forums allows governments to become smarter purchasers of new technology.)

These factors are equally applicable in explaining the importance of international S&T collaboration for Australia as they are for Canada. Our remoteness from the rest of the developed world makes our efforts to build international linkages all the more important. While it is sometimes claimed that modern communications and the Internet have 'shrunk' the world, the reality is that Australia gets no unique benefit from this 'shrinkage'. Our competitors also benefit from these technologies.

[45] Advisory Council on S&T (ACST), 2000, *Reaching Out, Canada, International Science and Technology and the Knowledge-based Economy*, Ottawa.

Researchers in North America and Europe can often find highly skilled colleagues and equipment in the same field within two hours of air travel. In Australia our low density and relatively low numbers of researchers do not provide the same opportunities. As a consequence international travel is an essential element of Australian S&T. For Australian researchers, the costs and the time required to maintain an involvement in international S&T are significantly greater than their European or North American counterparts. These facts are already widely recognised in the Australian S&T community and by those agencies that provide funds for research.

In recent times international S&T connections have grown in importance. In its recent study into international cooperation in R&D, by the Science and Technology Policy Institute at RAND[46], it was noted that scientific research is becoming:

- more globalised – with more countries now actively building their scientific capabilities and participating in world science;
- more collaborative – with a growing proportion of projects involving collaboration between investigators from more than one nation; and
- more distributed – with scientific teams collaborating across greater distances and involving more widely dispersed expertise.

The growing importance of international S&T collaboration reflects broader trends in relation to the importance of innovation to national economic performance, such as:

- the large cost of some major new facilities and the desire of countries to share these costs;
- the shift to a knowledge-based economy;
- the increasing importance of S&T as the source of new business creation and innovation; and
- the presence of information and communications technologies that facilitate global connections.

A best practice approach to supporting international S&T collaboration requires a clear idea of such drivers, both to specify the vision that ought to inform the development of international S&T connections and to provide a basis for developing policies and programs.

8.4 Australia's Need for International S&T

Effective participation in international S&T cooperation is critical to Australia's economic and social development. This participation contributes to advancing knowledge, creating wealth through innovation that leads to jobs and growth and enhancing Australian's quality of life. International S&T linkages play an important role in keeping Australian researchers abreast of overseas developments with international research cooperation, thus helping to maintain the high quality of Australia's own S&T performance. These linkages also contribute to the productivity of Australia's national innovation system by facilitating access to new technology both directly and indirectly for our business enterprises.

[46] RAND Science and Technology Policy Institute (RAND), 2000, *International Cooperation in Research and Development.*

Australia is highly dependent on the rest of the world for much of the S&T knowledge that it needs to maintain its strong economic performance and standard of living. If Australia creates about 2 per cent of the world's S&T it needs effective mechanisms to access the other 98 per cent.

Deciding to 'opt out' of international S&T is not a possibility, as it would leave Australia totally dependent on other countries to provide technology. In this situation, Australia would be exposed to the risk that the technology, which other countries supply, is not suited to Australian conditions. It would deprive Australia of a key contributor to our economic growth.

Australia is in a very different position to the US, where the research base has both breadth and depth. It is also different to Europe where the creation of a 'European Research Area' with strong internal S&T links with a considerable budget is aimed at creating a stronger research base, comparable with that of the US.

As noted above, one of the key drivers of international S&T cooperation is the cost of major research facilities. As science has become more sophisticated the cost of some of the equipment required to be scientifically competitive has also risen. The Square Kilometre Array (SKA), a new generation telescope, is expected to cost around $US1 billion. Without access to such facilities, Australian researchers cannot remain competitive.

Telescopes, particle accelerators, high intensity neutron and X-ray sources have all become so expensive that few nations can afford to build these facilities on their own. For Australia, the benefits of access to such facilities are considerable[47]. The benefits include enhanced scientific outcomes, international prestige, opportunities for better international relationships, access to scientific and technological advice. Economic benefits from hosting such facilities include increased employment, financial contributions from foreign partners, international contracts, regional development and increased tourism.

A recent report to DEST addresses this issue in more detail.[48] The report examines eight major international projects, of which four involve extensive Australian participation. The report concludes that significant benefits for Australia have been achieved and demonstrated. It also explains the need for Australian access to such facilities.

An effective system of international S&T links generates many other benefits. For example, such links can provide early access to new technology, leading to economic social, medical, environmental and cultural benefits. The acquisition and adoption of new technology through international linkages can improve the competitiveness of Australian products, ensuring domestic economic efficiency and increasing exports.

The skills and knowledge acquired through international S&T can flow back to the Australian workforce when university and business researchers transfer skills from overseas to students and colleagues. These can then be applied in Australian research and industry.

[47] Bell, J and Jensen, R, 1998, 'Assessment of the Socioeconomic Benefits Arising from Major International Research Facilities', Department of Industry, Science and Tourism.

[48] Johnston, R, 2002, *A Study of Australian Participation in multilateral Megascience Projects*, report to DEST.

To be internationally competitive, Australia needs a workforce with strong and up-to-date technological skills. To do this requires that Australia maintain a strong research effort. However, given our small size, no amount of domestic research effort will be sufficient to keep us abreast of technological developments in other larger industrialised countries.

Australia needs a strong technical workforce in order to be able to use, repair and maintain sophisticated equipment purchased from overseas suppliers, and Australia needs to be a sophisticated buyer, with the necessary technical knowledge to make informed purchasing decisions. Without this, Australia would be a technological price taker, forced to pay whatever prices were demanded. The country would have to produce higher volumes of commodity exports each year to pay for our technological imports and we would put ourselves at risk of being denied access to some technologies critical to our defence, competitiveness or welfare.

In a pluralistic S&T system such as Australia's and in other OECD countries, governments, universities, research agencies and businesses are all involved in international S&T connections in one form or another. To be fully effective in these circumstances, it is usually valuable for there to be a focus within government for such connections as well as appropriate machinery to ensure the views of the key stakeholders can be identified and taken into account in designing policies and programs.

The ARC and NHMRC have both received recent increases in funding. As a consequence they have increased their support for international S&T linkages and have encouraged international activities on the part of their grant recipients. However many researchers do not receive either ARC or NHMRC grant funds and therefore lack the means to become involved in international S&T activities. As a consequence, our funding system is preventing some of these researchers from realising their full potential.

As discussed in Chapters 4 and 5, there are excellent opportunities for Australia to become involved in major leading edge research projects in Europe and the US. However, the demand for IAP-IST Programme funds alone demonstrates that researchers are identifying international S&T cooperation opportunities in priority areas that Australia is not able to take up without a major increase in funds for international S&T activities. Without the funding to enable Australian researchers to become involved in these sorts of projects, we will get left behind by the rest of the developed world.

It is therefore essential that there are generally available funds to support international S&T and that these funds can be used flexibly to take up worthwhile opportunities as and when they arise. It is important that Australia devotes more resources to international S&T cooperation and ensures that these resources are directed into those areas that will generate the greatest benefits for Australia.

Most important of all, by providing access to the rest of the world's research, international S&T links contribute to the creation of new technology-based firms in Australia. The evidence cited in the international literature demonstrates that new technology-based firms are the major source of future economic growth and national prosperity[49].

[49] See for example, OECD, 2003, *The Sources of Economic growth in OECD Countries*, and other OECD references cited in this report.

8.4 Mapping Australia's International S&T Activities

The first step to understanding and evaluating the role of Commonwealth international S&T is to develop a clear map of these activities, outlining their nature and scope. Only then can the capacity of Australia's innovation system to contribute to economic growth and well-being be evaluated. This mapping process involves answering the following fundamental questions:

- How much does the Commonwealth spend on international S&T collaboration?
- With whom do funded organisations and researchers collaborate?
- Which Portfolios and Agencies fund and direct international S&T?
- What are the types and purposes of these activities?

Answers to these questions and the resultant detailed map of Australia's international S&T provide a foundation upon which effective policy mechanisms can be developed, to maximise the benefits of these activities for Australia.

The mapping exercise conducted in this study is a snapshot of Australian international S&T. It represents the first stage and lays the groundwork for what needs to be an ongoing analysis. An overall picture of Commonwealth international S&T has been produced for this study, despite the limitations faced by this first attempt. Chapter 3 provides a summary of results and highlights are noted here.

Commonwealth Government Expenditure on International S&T

Total expenditure on international S&T collaborations for the Commonwealth is estimated to be $211m (Table 3.3). This is approximately 6 per cent of the $3.4b estimate for *Total Commonwealth Support for Science and Innovation through the Budget and Other Measures* provided by DEST.[50] Although based on somewhat different methodologies, as discussed in Chapters 2 and 5, the Commonwealth estimate of 6 per cent can be compared roughly to the estimate by the RAND study for the US at 6 per cent of total R&D.[51]

Collaborating Countries

As discussed in Chapter 3, Australia collaborates with the European Union and more than 100 countries and economies. Over 80 per cent of expenditure on these collaborations is concentrated in 15 countries:

- The US is the leading single collaborating country in terms of both number of collaborations and expenditure on collaborations (25 per cent).
- The UK ranks second for both number of collaborations and expenditures (14 per cent).

[50] See Minister Nelson's and Minister McGauran's joint press release, May 13, 2003 and http://www.dest.gov.au/ministers/nelson/budget03/table3.pdf) The total given in this source for Support for Science and Innovation through the Budget and Other Appropriations is $4.7b. From this total the following expenditures are subtracted because these have not been characterised for their international collaborations: Expenditures for Defence, Science and Training Organisation (DSTO) ($340.3m) and Innovation Support including IR&D tax concessions ($957m). The resulting total estimate of expenditure on support for science and innovation from this source is $3.4b.

[51] RAND, *International Cooperation in Research and development: An Update to an Inventory of US Government Spending*. See Appendix Table C.1 for a breakdown by Agency or Department. Both the RAND study and this study use a 'bottom up' approach to estimating international S&T expenditures but the RAND study had access to itemised S&T expenditure accounts.

- Multinational collaborations with international organisations and large groups of overseas collaborators, rank third.

- Developing countries including China, Indonesia, PNG, Vietnam, the Philippines and India are included in the top 15 collaborating countries.

- Collaborations have been primarily concentrated with the countries and groups that have strong science and innovation systems. (Table 3.1 and Chapter 3 Figures.)

Nature of International S&T Collaborations

Collaborations reflect a multiplicity of Commonwealth international S&T goals.

- Most international activities involved individual Australian scientists working with overseas counterparts on a research project, grant or shared problem.

- In the case of ACIAR, the benefits from the collaborations flow not only from the aid aspect of Commonwealth collaborations but also from the value of contributing to advancement of S&T priorities in the Pacific region. These collaborations benefit the regions through the advancement of knowledge of researchers, including those based in Australia.

- Other activities support Australian participation in multilateral and bilateral fora (eg GBIF), and meet Australia's commitments to international standards and conventions.

International S&T Activity by Portfolio and Agency

Expenditures on grants by the ARC and the NHMRC represent 60 per cent of total Commonwealth expenditures on the international S&T collaborations. As shown in Chapter 3:

- More than half of the ARC and more than 85 per cent of the NHMRC estimated expenditures are with the US, UK and Multinational groups.

- ACIAR, EST, AFF and Environment and Heritage expenditures are more widely dispersed internationally.

Two programs, totalling less than $10m and 7 per cent of expenditure on international collaborations, are specifically geared to supporting and encouraging international collaborations by the Commonwealth.

- The IAP–IST program offered by DEST represents $6.7m or 5 per cent of total Commonwealth expenditure on international S&T.

- The ARC International-Linkages program represents $2.7m or 2 per cent of total Commonwealth expenditure on international S&T.

- For both programs, demand for grants significantly exceeded the funds available during the period under study (for more details see Appendix A).

Encouraging international S&T collaboration would benefit from an overarching Commonwealth policy, improved coordination and a more substantial funding commitment.

International S&T by Field of Research

As Chapter 3 shows, approximately one quarter of Commonwealth funded S&T research activities are in the Biological Sciences, with a further quarter split between Agricultural, Veterinary and Environmental Sciences and Physical Sciences.

- This result reflects the traditional comparative advantage of Commonwealth expertise in Biological and Agricultural, Veterinary and Environmental Sciences.
- The ranking outcome by collaborating country and field of research reflects the strengths of S&T activities of the countries with whom Australia collaborates. By and large, this ranking adheres to Australia's traditional science links.
- The more applied fields of research have a relatively small share of total international S&T activities. Inclusion of CSIRO, CRC and AIMS' international S&T activities would better identify the true extent of applied S&T within Australia's international S&T.
- A more detailed characterisation would provide more useful information about the type of research undertaken within the Biological Sciences, and across all Australia's international S&T.
- The ASRC system does not align with the National Research Priorities since the priorities are defined by outcome rather than by field of science.

Australia's ability to meet its National Research Priority Goals for international S&T outcomes cannot be tracked directly using the ASRC system. In order to relate international S&T collaboration expenditures to the National Research Priorities, granting and research performing organisations would need to gather this information for individual grants and projects.

International S&T by Purpose and Type

The main purpose of collaboration is researcher-to-researcher collaboration, and this was the predominant purpose and type for grants provided by the ARC and the NHMRC.

- Bilateral agreements, exchanges and fellowships are important forms of collaboration as well, particularly for EST, ACIAR and AFF.
- Accessing overseas equipment and expertise is supported through all agencies and portfolios except ACIAR, where bilateral agreements are the main purpose.

Identifying a full range of the purposes of research for all projects would be facilitated by better accounting for international S&T collaborations undertaken by Commonwealth Departments and Agencies.

Geographic Location of Researchers

Available data indicate that researchers involved in international collaborations are concentrated in metropolitan centres, primarily those in New South Wales and Victoria.

- This distribution of researchers is to be expected, especially for medical research which tends to be located at university medical schools and large metropolitan health centres.

- With some exceptions, such as the RDCs, information for geographic location of researchers is available mainly for the recipient organisation. Detailed information is largely unavailable for researchers who may be located in regional centres.
- It would be a significant task for funding organisations to track the regional location of all researchers involved in all international S&T projects. Furthermore, it is unclear how information about the regional distribution of researchers in Australia is directly related to S&T policy and goals. Other Commonwealth goals, such as reduction of regional disparity, which rely on regional-level data, may best be addressed through other policies and programs.

8.5 Role of Formal Agreements in International S&T

International S&T collaboration takes place in many cases where there is no formal agreement in place between countries or between organisations. In Chapter 3 and in the Appendices, the figures illustrating Purpose and Type of collaborative activity show that a relatively small proportion of the collaborations take place under agreements. In addition, most university researcher-to-researcher collaborative activities take place without (or in ignorance of) formal agreements.

However, the information received from funding agencies was not always characterised according to whether or not funding is provided under a formal agreement. Better information about whether or not agreements govern individual grants would provide for a better analysis.

Whether or not formal agreements govern most international collaborations, the use of agreements should be reviewed on a case-by-case basis especially given that there is a significant resources can be involved in seeking, negotiating, maintaining and complying with both bilateral and multilateral agreements. It is not the purpose of this study to evaluate formal agreements, however in the course of reviewing international collaborations, a number of questions were raised in relation to the purpose and usefulness of formal agreements.

In this section, the purpose of the formal agreements is briefly summarised guided by the following questions.

- What is the purpose of the bilateral or multilateral S&T agreements?
- Is it beneficial and/or necessary to have formal agreements?
- Is collaboration facilitated or hindered by the agreement?
- Does the agreement have a material impact on the quantity or quality of international collaborations?
- Is there a need for greater flexibility in formal agreements?

While it may be that a formal detailed review of formal agreements is in order, the next sections offer a brief outline of the purpose and value of international S&T agreements within the context of this study.

Purpose of Bilateral and Multilateral S&T Agreements

The purposes of agreements can include:

- Increasing the exchange of researchers and research students (including such issues as visas and work permits);
- Joint research projects (particularly to tackle large challenges or to address problems of common interest); and
- Facilitating discussions of policy issues, priorities, funding mechanisms, and major new projects.

Some countries, including Japan, China and Korea see S&T agreements as an essential element of international S&T cooperation. Other countries such as France and Germany see S&T agreements in a similar context to their cultural agreements. These countries tend to manage their international S&T activities through regular consultation meetings with partner countries.

Agreements have been established for two major categories:

- Strengthening national S&T capabilities; and
- Promoting closer political, social, economic and trade relations.

For the second category, this objective may be immediate, or it may address a perceived future need.

Both of these categories go beyond the responsibilities of any single government department. As a consequence, departments responsible for foreign relations often play a major role in the administration of such agreements. The difficulty with this approach is that such departments often lack the interest in and expertise needed to negotiate and manage such agreements. In pluralistic systems, Government-to-Government S&T agreements can impact on a wide range of science funding and performing agencies.

Government-to-Government agreements can also often provide an 'umbrella' under which agencies can develop more specific arrangements with their counterparts in other countries. As a consequence, there is a need for wide involvement of S&T funding and performing agencies in the establishment and management of S&T agreements.

At a laboratory or university level, such agreements may also promote closer links. However, much S&T cooperation takes place outside formal agreements by researchers who are not even aware of provisions that may apply to them.

There are concerns in some countries that agreements have been signed without adequate provision of resources to meet consequent expectations.

Some agreements do not contain review provisions, visa arrangements, management of intellectual property rights and other aspects of international S&T cooperation, which are currently seen as important.

At the highest level of international agreement, Australia is a party to thirty-two Government-to-Government Agreements. Appendix H provides a list of agreements for which DEST is responsible. In addition, important agreements operate at agency level (eg ARC and NHMRC), research organisation level (eg CSIRO and AIMS) and Academy level (eg ATSE). Sometimes agreements at this level fall under the umbrella of a government-to-government agreement.

There are also university agreements and agreements between individual research laboratories. Examples of current agreements are given throughout the Appendices.

Agreements with the US and the EU are particularly important because they provide Australian researchers with access to significant and often large-scale activities. However, there is a need to improve on the current availability of funding, often needed at short notice, to facilitate exploratory discussions on major projects.

Some of Australia's S&T agreements are now of less importance than they were at the time that they were signed. Further, Australia has no Government-to-Government agreement with some of the more important S&T partners because the need for an agreement has not arisen. S&T agreements involve administrative costs and raise expectations on the part of both researchers and foreign governments regarding the commitment of resources. Yet few of Australia's S&T agreements have earmarked resources and, for the few that do, these resources are very small and significantly less than the foreign partner is willing to commit.

In commenting on a similar situation in the US, the General Accounting Office (GAO) report referred to in Chapter 5 noted cases where the lack of committed budget resources had prevented implementation of international S&T agreements.[52]

Some S&T agreements identify specific fields that are to be given priority in cooperation activities. Over time, priorities change and agreements need to be reviewed. A better approach is to first establish whether having an agreement serves a useful purpose under the particular circumstances and if so, then a formal priority–setting process and set timeframe for review needs to be established within the agreement.

A whole-of-government approach is required to S&T agreements. Principles for guiding the purpose of agreements include the following:

- Agreements should only be established where they serve some necessary purpose;
- Agreements need to contain a clause that sets a review date; and
- There needs to be an understanding by both sides about likely levels of activity and funding for Australian involvement and this needs to be identified for the duration of the agreement.

8.6 Relationship of International S&T to National S&T Priorities

Since the announcement of *Backing Australia's Ability,* the Commonwealth's National Research Priorities have been refined and focussed on the following four 'whole of government' themes:

- An Environmentally Sustainable Australia;
- Promoting and Maintaining Good Health;
- Frontier Technologies for Building and Transforming Australian Industries; and
- Safeguarding Australia.

A number of sub-themes have been identified under each of these major themes (see Appendix I).

[52] United States General Accounting Office, 1999, *Federal Research: Information on International Science and Technology Agreements*, GAO/RCED-99-108.

This study has found that, at a broad level, most of the countries analysed share common technology priorities – ICT, biotechnology, nanotechnology, etc. At this broad level, attempts to match Australia's priorities to those of countries with which we might wish to promote cooperation are not particularly useful.

At a finer level of disaggregation, which can be seen for example in the discussion of the US priorities, it would appear difficult for government agencies to attempt to match Australian research effort with what are essentially niche research areas. There are some examples where this has been achieved such as bioinformatics. However, where bioinformatics was once seen as a narrow, well-defined field, it has now become much broader in terms of areas of application, technologies and applications. The US NSF view, that *researchers* are best placed to identify their leading counterparts in such areas, has considerable merit.

As recommended in this study, improving on the quality and quantity of international collaborations will enable researchers based in Australia to make the kind of advances in S&T that will improve on Australia's competitive advantages in line with the national research priorities.

8.7 Analysis of International S&T Policies and Practices

Australia's circumstances are unique in terms of being a developed country of medium size, which is located at a considerable distance from the centres of world S&T development in North America, Europe and Asia. Nevertheless, much can be learned from examining the approaches followed by other countries to enhancing international S&T connections. In this section, the conclusions drawn from this study are summarised with a view to establishing best practice for Commonwealth international S&T policy.

In broad terms there appear to be three key drivers of international S&T strategies of many developed countries.[53] These are based upon participation in:

- International research activities;
- Information networks and international fora; and
- Bilateral and multilateral cooperation agreements at governmental and agency level, as discussed in more detail above.

The ability of countries to participate in and benefit from international S&T collaboration depends on a number of factors, including:

- The strength of a nation's science and innovation system is particularly important. If Australia is to attract interest in S&T cooperation from world leading researchers and research organisations in other countries, we must have a high quality well-funded S&T base.
- The level of public funding for S&T activity is taken by potential partners as an indicator of whether S&T cooperation is worth encouraging. Higher levels of funding for S&T activities in public research centres and universities may allow for greater participation in large-scale international S&T activities.

[53] Voyer, R., 2000, *International S&T Strategies: An International Comparison*, Prepared for the ACST Expert Panel on Canada's Role in International S&T.

- National economic, legal, cultural and social frameworks are also important to international S&T cooperation. Data and intellectual property protection are increasingly seen as important by partner countries. Foreign investment and immigration policies determine the freedom of international flows of information, S&T funding and people.

- Networks and other arrangements for promoting international S&T cooperation are critical to securing optimum benefits for Australia. This requires an up-to-date knowledge of emerging areas of technology in other countries and of researchers and companies that are active in these areas in Australia. It also requires the resources to develop and implement strategies for collaboration with key countries. The Canadian review of science and technology policy in 2000 recommended that the preferred method of matching foreign opportunities to national resources is to position appropriately skilled science counsellors around the world.

- The level of business R&D is important in terms of capturing benefits from international S&T cooperation. OECD studies suggest that, other things being equal, countries with high levels of business R&D gain relatively more from international S&T than nations with lower business R&D[54].

Based on analysis of OECD[55] and other material referred to in this report, a number of general conclusions can be made regarding the international S&T strategies employed in most OECD countries.

Defining the objectives of international S&T is a prerequisite to understanding the support that is provided for this activity. One major objective is to maintain close contact with world leaders in relevant areas of science and technology. However, there are other important objectives that countries seek to achieve through international S&T. These include development assistance, trade, defence and political objectives. Support for and management of international S&T needs to take into account these different objectives.

There is considerable evidence of growth in international S&T activity. Most countries, and in particular the US, Canada, France, Germany and Italy, are giving increasing attention to international S&T. New efforts are being made in OECD countries to coordinate and measure international S&T. The RAND and INCOPOL reports are, themselves, indications of increasing recognition of the importance being placed on the contribution of international S&T to national economic and social objectives. In addition, the very high cost of some major research facilities is driving smaller countries into allocating additional funds to cost-sharing international arrangements.

There is evidence from the RAND, INCOPOL and OECD reports cited in this study, as well as information from national sources, that many countries are increasing the levels of funding available for international S&T. Since 2000, Switzerland, Sweden, Canada, New Zealand, the United States, the EU, Austria and Japan have all either announced new international S&T programs or are in the process of refocussing their current international S&T strategies.

[54] OECD, 2001, STI Working Paper 2001/3, *R&D and Productivity Growth: Panel Data Analysis of 16 OECD Countries.*

[55] OECD, 2002, *OECD Science, Technology and Industry Outlook 2002;* and Advisory Council on S&T, 2000, *Reaching Out, Canada, International Science and Technology and the Knowledge-based Economy*, Ottawa.

Other OECD countries are providing international S&T funding for a wide range of activities including researcher-to-researcher collaboration, researcher and student exchange, access to and investment in major facilities, support for international conferences, participation in major research projects and exploration of opportunities to be involved in such projects, joint seminars and workshops and international networking arrangements. Funding mechanisms need flexibility and breadth in order to be able to respond to these different modes of international cooperation.

Most countries provide generally available grants, as well as grants which are tied to peer reviewed research grants. Some international S&T activity is also funded through institutional or block grants (similar to that provided to Australian universities and the CSIRO), and through funds that are provided to promote other objectives (in Australia, the CRCs are a relevant example). The need for both generally available and peer reviewed funds reflects the mix of objectives of international S&T discussed above. While it is important to promote links between excellent researchers, there are other legitimate objectives that call for generally available funding.

The ability of grant programs to address needs and opportunities as and when they arise has been given some attention in other countries. Annual grant cycles clearly have serious limitations in this regard. The US NSF has adopted a continuous assessment approach to the processing of applications for some of its international S&T programs.

Managing international S&T cooperation also requires specialist dedicated resources. An effective science counsellor network ranks high among the priorities of the countries reviewed in this study. Such networks need to be supported at the national level, including coordination of various agencies involved in international S&T activities.

At the same time, there is merit in providing support for arrangements such as FEAST, which harnesses the enthusiasm of interested researchers and leverages support from other countries.

Most countries seek to involve a range of players in international S&T activities. While individual researchers are most important, some countries also provide funding targeted at groups of researchers, small and medium size companies, early career researchers, female researchers and researchers from minority or expatriate groups.

In the context of bilateral discussions it is logical for countries to seek to establish cooperation in areas of common interest. In addition, a number of countries commonly refer to their national priorities when advertising the availability of grant funds. The process of review adopted by the ARC appears to represent best practice in reviewing projects for relevance to priority areas. Beyond these approaches, the study has found that attempts to match priorities for the purpose of guiding international S&T activities have usually focussed at a broadly defined level.

8.8 Further Work

The overview of international S&T efforts provided in this report has raised a number of further questions that complement this exercise. These issues have been raised in the discussion of a number of programs and are collected here.

- To what extent do Commonwealth expenditures on S&T leverage funds from international partners? This additional tracking exercise would be possible if the Commonwealth's international expenditures were being recorded and monitored.

- International S&T collaborations have received priority status at a whole-of-government level in other countries. If this priority status is recognised by Australian granting organisations level then grant applications, will be evaluated taking into account the extent of international collaborations. This would ensure that researchers understand that their efforts to develop and sustain international links are valued. In many cases reviewed, it appeared that there may have been international collaboration but the grant applicants had not provided details, presumably because they perceived that this information would not have improved their chances of winning a grant.

In summary, what is required is that:

- Policy priority is set at the Commonwealth Government level recognising the value of international collaboration;
- A priority for international collaborations is established;
- Grant selection criteria are revised, to take international collaborations into account; and
- A tracking system for international S&T activities is implemented at the Departmental and Agency level.

Chapter Nine

Conclusions

In this section we list the major issues that arise from this study. These issues require the application of the international best practice which we have identified throughout this report, taking into account Australia's particular circumstances including geographic location and pluralistic model of S&T support.

9.1 Recognising the Importance of International S&T

As shown in our analysis of the policies and practices of other countries, best practice requires having well defined international S&T goals and objectives. Goal setting needs to be done at national as well as at agency level. Agencies should set objectives for international S&T which link to their missions. An emphasis on the importance of international S&T needs to be reflected in the nature of support available for international S&T activities and guidelines for relevant research funding programs and research performing agencies. As discussed in Section 8.4, an overarching Commonwealth policy for international S&T is needed.

As demonstrated by the reports cited in this study (eg RAND, INCOPOL, ACST), there is a need to articulate Commonwealth Government policies that recognise the importance of international S&T and define the key underlying principles for funding and research performing agencies.

Nationally and at the agency level, Australia needs to explicitly recognise the importance of international S&T. This recognition needs to be reflected in agency programs, research activities and other S&T related activities.

9.2 Measuring International S&T Activity

International S&T collaborations play a critical role in facilitating access to the 98 per cent of the worldwide investment in technology that we do not invent ourselves. It is therefore important that we in Australia monitor and measure our own international S&T activities. This task is made all the more important by the fact that much of our international S&T activity is dispersed across a large number of research projects and institutions. It is significant that both the US and Europe, which might have been considered to be much more self sufficient than Australia in terms of developing new technology, have both come to a similar conclusion.

Informed policy decisions on international S&T issues require data. Measuring international S&T activity need not be a burden on research funding and performing agencies. Most agencies already have databases that record other details of their activities and, with some modest extensions, could provide a standardised source of information on international S&T activities across Portfolios and Agencies.

As discussed in Chapters 2, 3 and 8, this data needs to include information about the purpose and type of international S&T activity, the research field classification, whether the project addresses an Australian National Research Priority and whether the activity takes place under a formal agreement.

A simple framework for recording international S&T activity on a common and consistent basis across the Commonwealth is required to achieve best practice in the management of Australia's international S&T effort. This framework needs to be implemented across all R&D funding and performing agencies. Departments and Agencies should be reporting international S&T activities on an annual basis. This information could be the subject of an annual report issued by the Minister responsible for Science, the Chief Scientist, or the Coordination Committee on Science and Technology.

9.3 Coordinating Australia's International S&T Effort

As this study has shown, many countries (particularly the US, Canada, the UK, Japan, China and Korea) have recognised the need for such coordination arrangements. In the case of the US, this is achieved through a subcommittee of the National Science and Technology Council, whose Australian counterpart is the Coordination Committee on Science and Technology (CCST). The Terms of Reference for this subcommittee (CISET) can be found at Appendix G. The UK's coordination committee has similar functions.

There are a number of reasons for improving the coordination of Australia's international S&T activities. For example, many international S&T activities cross Departmental and Agency boundaries. International cooperation in agricultural research is potentially of interest to AFF and CSIRO and could be supported by DEST's IAP-IST Programme. Given the fragmented nature of Australia's international S&T effort, improved coordination of such activities can be expected to ensure that we get best value from them.

Some improvement in coordination can be achieved through cross membership of committees allocating grant funds, but national level coordination is required. This coordination needs to include formal S&T Agreements and science diplomats. It therefore needs to involve the Australian Department of Foreign Affairs and Trade.

Best practice in other countries, especially those with pluralist S&T systems, indicates a requirement for improved coordination of Australia's international S&T activities. This can be expected to ensure better allocation of resources and reduce the possibility of overlap and duplication between agencies. The coordination task should be the responsibility of a standing committee of the Coordination Committee on Science and Technology.

9.4 Measures to Encourage International S&T

Commonwealth Government support for international S&T is provided in four major ways:

- Dedicated international programs such as the ARC's Linkage-International Program and DEST's Innovation Access Program (IAP)–IST;
- Other programs which aim to support domestic S&T activities, where there is an international component;
- Contributions to the operating costs of major international research facilities such as the ARC contribution to the Gemini project; and

- Funding on national research organisations (eg CSIRO) and universities where staff are involved in international S&T but the major Commonwealth contribution is in the form of salary.

Each of these forms of support is important in its own right and each can be benchmarked against best practice in other countries. For organisations that fund research on the basis of excellence, the main issue is whether they are encouraging international cooperation by providing the necessary levels and types of assistance.

Studies referred to earlier in this report have identified informal or bottom-up researcher-to-researcher as being a very important component of a country's international S&T effort. In addition, some international S&T is undertaken in support of broader goals. Thus generally available support of the type provided by IAP–IST fills a very important need.

In relation to bilateral agreements, US, Canada and European reports have all recognised the need to identify specific funding at levels that meet the expectations of both partners.

This study has found that, especially given Australia's location and the nature of our economy, funding for international S&T does not compare well with the other countries reviewed. On the basis of the details reported in Chapters 4, 5, 6 and 7 it is the view of the study team that Australian international S&T funding is insufficient, does not provide for the full range of measures facilitating international S&T that are available in other countries, and allows for Australian researchers to take up only a limited number of the valuable opportunities available to us. At a time when the rest of the world has realised the importance of international S&T and has developed policies and programs that recognise this importance, Australia's funding mechanisms for international S&T are inadequate and insufficient.

Additional funds are also required to enable Australian researchers to explore opportunities to participate in major new international initiatives such as the Global Biodiversity Information Facility (GBIF) and to seek involvement, at the conceptual and design stage, in leading edge projects such as those within the EU Framework Programmes. As discussed earlier in this report, many OECD countries have recognised the importance of such early involvement and have moved to address these needs.

Best practice in international S&T requires that increased funds are available from a mix of sources to cover the different modalities of international S&T activity, recognising the importance of these links in providing access to research outcomes from S&T activity in other countries.

9.5 Nature of International S&T Activities

As this study shows, other countries provide support for international S&T through a range of different measures. Each measure contributes to the overall goal of gaining benefits from the rest of the world's S&T expertise. Australia has some measures in place, particularly through the ARC and the IAP-IST Programme. However these fall well short of what is needed.

New or upgraded measures are needed to address the following.

Major international S&T (megascience) projects

Megascience projects can involve researchers from a wide range of institutions. Membership of international megascience projects can result in funding demands on a number of different agencies (eg GBIF). For these reasons, opportunities to participate in major international S&T projects generally require a carefully planned and coordinated multi-agency approach.

There is a strong case for a single coordinated fund to support Australia access to megascience projects. Such a fund would have the flexibility to be able to support exploratory discussions, provide a framework for deciding which megascience facilities and projects that Australia will participate in, support the preparation of cases for assisting some of the facilities in Australia, provide Australian contributions for the establishment and operating costs of facilities and supporting access by Australian users to these facilities and projects.

International Conferences

As this study has shown, smaller OECD countries such as Finland, Ireland and Switzerland see benefits in attracting S&T conferences. There are both scientific and economic benefits from hosting such conferences. They provide an opportunity to showcase Australia research to international peers, and to engage these visitors in discussions that benefit the development of Australian S&T.

When international S&T conferences take place in Australia there is greater opportunity for participation by Australian researchers, particularly students. Overseas researchers attending conferences often also include visits to Australian research facilities in their itinerary. This generates benefits for Australia in terms of accessing the expertise of the rest of the world. Hosting such conferences in Australia also bring economic benefits through additional tourism.

Rapid response mechanisms

Establishing and maintaining an adequate presence in the international S&T research community requires not only the ingredients recommended as part of this study. Good timing is required as well.

Research efforts undertaken by collaborators have a timing sequence that waits for no one. While governments delay in providing adequate support to international S&T collaboration, opportunities that come only once are lost. The pace of progress is fast and each new collaborative group that forms is like a 'club' with limited access. When researchers come together and move forward, there is limited opportunity for latecomers to join.

Within granting schemes, there is a need to provide for new international cooperation activities as and when they arise. As this report has shown, other OECD countries are establishing such arrangements, and Australia needs to do so too. These mechanisms need to cover such activities as exploratory visits to seek involvement in the EU Framework Programme projects.

Commonwealth Government funding for international S&T activities needs to provide rapid response mechanisms in order to ensure that Australian researchers are able to engage in new international projects from the earliest stages.

9.6 Formal S&T Agreements

Most countries are signatories to a collection of formal bilateral and multilateral S&T agreements that have accumulated over the years. As discussed in Chapter 8, these agreements can be national, or can be agency-level agreements. They come about for different reasons. In some cases, they provide a useful framework for a wide range of specific and/or informal cooperation activities. These agreements can facilitate visas for visiting researchers, and set out general conditions for the sharing of intellectual property arising from cooperative research. For some countries where international S&T cooperation is centrally managed, bilateral agreements provide an essential pre-condition to annual discussions between officials on what projects will be supported.

International best practice indicates that bilateral S&T agreements should be subject to regular review by the signatories. New agreements should provide for such reviews. Bilateral S&T agreements should be terminated (by mutual agreement) where they no longer serve any useful purpose. Agreements that do not adequately address intellectual property arrangements may need to be renegotiated. International best practice suggests that there needs to be adequate sources of funding to ensure that expectations are met and to avoid circumstances where the other country is regularly proposing numbers of projects which are judged to be of merit, but for which our researchers are unable to obtain the necessary funding or unable to obtain it in a timely manner. A whole-of-government approach is needed in relation to the management of bilateral S&T agreements.

Additional funding is needed to provide realistic levels of support for activities under the international S&T agreements to which Australia is a signatory, recognising the importance of these links in providing access to research facilities and research outcomes in other countries. Bilateral S&T agreements should be subject to periodic review.

9.7 Involvement of Early Career Researchers

It is well established that for most researchers the most significant scientific advances are achieved in the early years of their careers. However, many researchers have difficulty in attracting research grants in their early years because they have not yet established a track record of achievement. To over come this problem, some research granting bodies have created special granting programs that specifically support early career researchers.

This same issue arises in relation to the involvement of early career researchers in international S&T cooperation. Post doctoral and other fellowships allowing early career researchers to gain overseas experience provide an important building block for future international S&T cooperation. However, overseas studies indicate that such fellowships, in themselves, are not sufficient. Increasing recognition is being given by OECD and other countries to the need to provide targeted funding to assist career researchers to establish international links in their field of interest.

As documented in the earlier Chapters of this report, a number of the countries now provide (or in the case of Canada are moving to provide) specific support for early career researchers to assist them in building international links.

Early career researchers should receive extra incentives to undertake international collaborations. This investment will provide lifelong dividends and make an important contribution to keeping our researchers at the leading edge of their field.

9.8 Addressing Intellectual Property Rights Issues

One real concern with all collaborative work is the real risk of losing rights to intellectual property. Some general guidelines have already been developed. The NHMRC has noted this as a consideration that they must address in their policy development activities.[56]

When international S&T collaboration is undertaken, researchers need to be fully aware of the rules of host and partner institutions in relation to intellectual property rights. Since Australian public benefits are lost if rights are lost, it is necessary for Commonwealth Government Departments and Agencies to ensure that all researchers that they support are aware of intellectual property policies and agreements through a comprehensive information program.

There is a need for researchers involved in international S&T projects to be made more aware of the issues regarding intellectual property rights. Researchers involved in international S&T activities need to be made fully aware of relevant intellectual property policies when grants are awarded.

9.9 International S&T Information and Liaison Network

The experience of countries analysed in this study is that science counsellors located in key countries best facilitate international S&T cooperation. Australia is currently inadequately provided for in this regard. Such a network needs to be staffed with suitably qualified individuals whose mission is to increase the flow of information about, and facilitate S&T cooperation activities with the country to which they are posted. The French and Italian science attachés in Canberra are excellent examples of the professional approach required. In the past, Australia had an operational science counsellor network but changing Departmental responsibilities and an absence of coordinated tasking has resulted in this network declining over time.

There is no substitute for having a science counsellor posted in major countries of interest. Past experience indicates that such staff are able to serve the needs of a range of agencies. This, however, has meant that they have been perceived as not providing adequate benefits to the Department paying their salary. A whole-of-government approach is needed.

An expanded and effective science counsellor network is required to ensure that Australian international S&T interests are progressed in major countries with which Australia seeks to foster closer S&T links. On the basis of the numbers of such posts established by other countries, Australia needs such positions in at least four European, two North American and three Asian capitals.

[56] NHMRC, 2002, Investing in Australia's Health: Review of the implementation of the National Health and Medical Research Council's Strategic Plan 2000-2003.

Introduction to Appendices

Detailed Methodology

This section provides additional detail to the Methodology Chapter (Chapter 2). Here the implementation of the methodology is discussed in more detail than in Chapter 2, without repeating the details in Chapter 2. Chapter 2 should be read along with this detailed methodology. Here, particular attention is given to difficulties and limitations encountered when collecting data, as well as the data constraints, which affect interpretation and analysis of results.

Data Requests and Collection

In order to obtain information from Commonwealth research funding and performing agencies, an initial approach was made to senior officials by DEST. This was followed this with working–level consultations in order to explain the aims and objectives of the project and obtain help in the provision of data on international S&T activities and funding arrangements. These consultations included the Academies of Science, the Academy of Technological Sciences and Engineering and Engineers Australia, as well as the Australian Vice Chancellors Committee.

In addition, the assistance of two universities — the University of NSW and the Australian National University has enabled the development of a picture of international S&T activity at an institutional level to highlight activities that would not otherwise have been captured.

Because this is the Commonwealth's first attempt at undertaking a comprehensive study of Australia's international S&T activities, it was inevitable that there would be significant problems obtaining the necessary data. To varying degrees, individual staff in Departments and agencies provided assistance in obtaining information required from existing data sources. In some cases, it was necessary to review original grant applications in order to obtain sufficiently detailed data. The three main sources of information were:

- department and agency data sets;
- department and agency annual reports and websites; and
- personal communications.

In some cases, existing data sets included information about R&D grants. Examples here included the Australian Research Council data sets that document grant details for successful grants. Some international information was available from these data sets. For some grant programs, information was collected by reviewing individual grant applications or summaries (eg the ARC Linkage-International Program).

Where there are no R&D grant data sets available, information from funding organisations was collected on a project-by-project basis from funding agencies. The procedure followed is summarised below.

Requests

- Phase 1
  - Initial official request to departments.
  - Follow-up requests to portfolio agencies and other organisations responsible for Commonwealth expenditures on S&T.
  - Phone contact to explain request.
  - Meetings with the majority of organisations contacted.
- Phase 2
  - Distribution of spreadsheets to all organisations involved.
  - Follow-up contact to confirm spreadsheets were received.
  - Explain spreadsheet details.
- Phase 3
  - Identify further sources of Commonwealth international S&T expenditures and send out requests for information with follow-up as for Phase 2.
- Phase 4
  - Re-contact to remind and encourage reporting back.
  - On-going contact to collect data, refine and confirm receipt.

Data Collection Tools

- Development and on-going refinement of the unique spreadsheets tailored for collecting these specific data.

Data Review

- Receipt and review of information from organisations that provided data.
- Correction of entries.
- Re-contact to confirm assumptions, further clarification and request for greater detail was required in almost all cases.

Data Analysis

- In-house data analysis of large data sets provided by ARC and NHMRC and CSIRO.
- Standardisation of data presentation into the format provided here.
- Aggregation of reports by smaller organisations.
- Production of summary tables and figures for report presentation.

Data Collection

Spreadsheets

Standardising the data collection process is imperative in an exercise of this dimension. Hence, early in the process, standardised spreadsheets were produced for entering all information required. The spreadsheets, which are included in Appendix H to this report, summarise the information required in order to characterise all international S&T expenditures and activities in a consistent way.

Although some organisations were not able to provide all the required information, the spreadsheets provided all participants with a clear picture of what the international S&T mapping exercise entailed.

Base Year

In general, the approach taken for this study has been to seek data for the latest available year. In most cases, this has been the financial year 2001-2. In some cases, calendar year 2002 has been chosen because of agency grant year reporting and data gathering arrangements. In one case, for the DEST Innovation Access Programme – International S&T (IAP-IST), the year 2002-3 has been selected, at the request of DEST, because 2001-2 was an atypical year.

Mapping activities require the latest available data. Given the significant structural changes in S&T support in recent years, it is difficult to map the past. Mapping the most recent available year, however, conflicts with a secondary objective of the study — to develop an understanding of the output of Australia's international S&T activity. Normally, in order to track output and outcomes, a base year would be chosen for analysis that was sufficiently distant such that the outputs/outcomes would have already become evident, but not so far in the past that the possibility of tracking these results is reduced by a lack of records.

Geographic Location of Researchers

This study extends the reporting methodology used by granting bodies. When they do show geographic distributions, granting bodies typically show distributions for the grant recipient. This approach is extended in this study to include not only the location of the grant recipient, but, where possible, the total number of researchers involved in the projects and their geographic base in Australia.

The task of plotting geographic location is limited by the data, which typically show the grant recipient location as the home university rather than the field site. For this reason the analysis cannot be used to make complete inferences about the regional distribution of research activity in Australia. Inferences are limited to distributions at the state level in most cases. The split between metropolitan centres and non-metropolitan centres is shown, however, little information has been provided for researchers located in non-metropolitan areas. Although the data available cannot be used to reliably estimate the metropolitan/non-metropolitan distribution, it is evident that most research centred in metropolitan centres. This seems to be a reasonable result for Australia where it is likely that most S&T research is centred at universities and these, for the most part, are located in the metropolitan centres.

Sampling

Where there are large numbers of grants or activities, such as for the National Health and Medical Research Council (NHMRC) Project Grants and Fellowships, international collaborations were not always recorded. This is because international collaboration may not be the focus of the particular grant programmes and therefore this information is not collected as one of the grant characteristics. However, many of the approved grant applications do record international collaborations that needed to be acknowledged for this study. Time limitations restricted efforts in sampling from the total population of grants.

Two simplifying assumptions were made in our sampling procedure.

- The analysis has been concentrated on new projects funded in the latest available year.
- Where the expenditure of a funding agency involves multi-year projects it is have assumed that continuing projects that were supported in the latest available year have the same characteristics as the new projects that commenced in that year.

For example, there was a total of 1,390 NHMRC Project Grants receiving funding in 2002. Of these, there were 401 three-year Project Grants starting in 2002 (excluding equipment and development grants, which we were advised would not be international in nature). A sample of 78 from the 401 was taken for the details of their international collaborations. The sample information was then applied in scaling up to an estimate of the total international activity represented by all Project Grants, assuming that the sample characteristics apply to the population as a whole.

The limitations of sampling are acknowledged, but in the absence of information about the whole population, sampling is a next-best approach to obtaining an indication of the kind of international characteristics that are reflected in a fairly narrowly–defined grant programme. More details on the individual methodologies adopted for each program element and agency activity are listed in the Appendices.

Data Analysis

With the exception of defence, this study has sought to develop a whole-of-government picture of Australia's international S&T activities, identifying the countries, areas of research, researchers and forms of support. This has involved analysis of data by purpose and type of activity.

Projects with an International Component

One of the major challenges of this study has been to estimate the international component of research projects that, while predominantly domestic in nature, have an international element. Counts of collaborations are less challenging while expenditure on the international portion of activities is more so.

Counts provide a simple indication of international activity, however, as noted in the CSIRO report on international activities, the number of collaborations will exceed the number of actual projects in all cases where there is more than one collaborator from overseas. The number of collaborations by country have been counted in order to reflect the minimum extent of international collaborations. This is consistent with ARC and CSIRO practice where an individual country is counted once even in the case where more than one researcher from that country is involved.

While remaining as consistent as possible, it was necessary to adapt our general methodology for some programmes. For example, in the case of the Academies of Science, large-scale conferences were analysed outside of the spreadsheet format. If all participants had been counted, as was done for all other international activities, a large number of country collaborations for one conference activity would have been included. It is likely that such an approach would skew the illustration of the number of collaborations beyond that which would meaningfully reflect international S&T activities. As a result, large-scale conferences separately were dealt with separately.

There are programs, such as the ARC Linkage-International Program, for which it is clear that all activities should be counted as international in nature. In some other cases, the funding agency had close enough contact with the activity to offer an estimate of the extent of the international portion of the total S&T activities. Where this was not possible, the following necessary assumptions were made.

- If the main purpose of the activity was international, then 100 per cent of the activity was counted as international. An example would be membership costs to belong to an international organisation.
- If the activity depended on the involvement of key overseas participants then 100 per cent of the activity was counted as international.
- If there was an overseas Principal or Chief Investigator, then 100 per cent of the activity was counted as international. This was the recommendation made by ARC and it was adopted generally for all programs where a decision was necessary.
- If there were international participants other than Chief or Principal investigators, then the share of total Commonwealth expenditure which was international was estimated by weighting the total expenditure by the share of all researchers who were from overseas.

Specific issues are dealt with individually in each of the Appendices in this report.

Multinational Collaborations

For this study collaborations are defined as 'multinational' in specific circumstances, including the following.

- If a project involves more than six countries, the project is defined to be multinational in nature and no one country is defined for the allocation of expenditures. The category is defined as 'multinational'. Shares of expenditures are allocated as described above for cases where the project is considered to be either 100 per cent international or partially international.
- Examples include ARC Discovery and Linkage grants where up to six countries are listed where there are international partners. For the NHMRC, analysis of a sample of Project Grants indicated that there were many grants that involved a large number of Associate Researchers who are located around the world in more than six different locations.
- If a grant is given to a recipient to investigate options that may involve a large number international sites that are as yet, undefined, then the expenditures are listed as multinational. Examples may include Innovation Access Programme grants for investigating international options for partnering.

- If collaboration is with a multinational organisation such as the International Atomic Energy Agency, then the expenditure is listed as multinational. Exceptions to this include collaborations that are exclusively with the EU, which are listed separately for this study.

Field of Research

International collaborations were analysed according to their field of research. The broader, 1993, Australian Standard Research Classification (ASRC) is used for the 11 fields of research (see Table A). Law and Humanities fall outside the scope of this S&T study and Defence expenditures are unavailable due to security reasons.

Allocating a field of research is not straightforward, particularly as many new and emerging fields of research are by nature, multidisciplinary. Furthermore, individual collaborations often involve research expertise and equipment from a variety of research fields, making it difficult to describe some of them by a single field of research. Many researchers, when approached to nominate a single field of research, were uncomfortable doing so. However, utilising additional classes of research fields would ultimately be unhelpful due to problems of statistical significance and sample sizes.

Table A

FIELD OF RESEARCH CODES - ASRC

	ASRC field of research – 11 subdivisions
1	Mathematical Sciences
2	Physical Sciences
3	Chemical Sciences
4	Earth Sciences
5	Information, Computer and Communication Technologies
6	Applied Sciences and Technologies
7	General Engineering
8	Biological Sciences
9	Agricultural, Veterinary and Environmental Sciences
10	Medical and Health Sciences
11	Social Sciences

Source: Australian Bureau of Statistics, (1993) Australian *Standard Research Classification a set of classifications for R&D projects*, ABS Catalogue No. 1297.0

Specific difficulties with fields of research are commented on in the Appendices. For example, as detailed in Appendix C, the NHMRC codes do not correspond with this ASRC system. Specifically, for the purpose of this study, the grants designated as Basic Science according to the NHMRC codes, are categorised as Biological Sciences under the ASRC system. The Medical Science field under NHMRC is categorised under ASRC Medical and Health Sciences according to fields for this report.

Accounting for Researcher Time and Salary

Another challenge has been to estimate the value of Commonwealth researcher, agency and researcher time on international S&T. For example, many projects are essentially national in focus but involve international components. Staff do not, as a general rule, measure the time which they allocate to research projects. Even if they did, attributing part of this time to international S&T would be very difficult. The RAND study encountered similar problems, as discussed in Chapter 5.

Data Constraints

Collecting S&T Data

International S&T activities typically are not identified and recorded on a financial basis by Commonwealth departments. Public accounting and reporting systems are not designed to require accounting of international activities and therefore, while it may be possible for managers to list international activities by numbers of staff involved or numbers of projects, providing details on activities and expenditure is more difficult. Although it was not a simple task, portfolio agencies were generally better able to provide this information, presumably because their governance frameworks required this sort of expenditure to be reported on an annual basis.

The relative size of international S&T expenditures is estimated in the Appendices and summarised for the Commonwealth in Chapter 3. There are a number of data constraints mentioned throughout the text that qualify the estimates. For example, when agencies reported total S&T funding and their estimate of the international S&T portion, they may not have included all S&T funding. In some cases they reported only the S&T activities that would have some portion as international. Hence, the total share of international S&T may be overestimated. However, it is much more likely that the estimates of international activities are too low since many international collaborative activities may not have not been identified by organisations in this first attempt to map them.

Furthermore, in a number of cases, data simply are not available for international S&T activities. This is mainly because these data are not collected separately by funding organisations at the time that expenditures are funded. For example, CSIRO does not record annual expenditures made on international S&T collaborations so it is not possible to characterise CSIRO expenditures using the bottom-up approach. However, CSIRO has provided useful and detailed information that allows for an extensive analysis of international S&T activities according to collaborating country, area of scientific research and purpose of the activity.

Appendix A

The Education, Science and Training Portfolio

In the Education, Science and Training Portfolio there are both funding programs and research performing agencies involved in international S&T. The major sources of program funding are summarised in Table A1. The Department of Education, Science and Training (DEST) administers some programs, while the Australian Research Council (ARC) administers others.

Table A1

PROGRAMS SUPPORTING INTERNATIONAL S&T

Department of Education Science and Training	*Year*	*Commonwealth S&T Expenditure (1)*	*International S&T Expenditure Analysed*
Innovation Access Programme – (International S&T)	2001-2 2002-3	$4.1m $7.7m	$6.7m (2)
Major National Research Facilities Programme	2001-2 2002-3	$4.5m $25m	$0.2m (2)
Cooperative Research Centres Programme	2001-2	$146.5m	$5m (2)
International Postgraduate Research Scholarships	2001-2	$15m	$11m
Australian Education International Programme	2002	$2.45m	$2.45m
Fullbright Awards	2001-2	$0.7m	$0.7m
Australian Research Council – (NCGP) (3)	2002	259.3m	$53.4m

Source: The Allen Consulting Group
Notes: 1. Some of the figures in this column are from Minister Nelson's and Minister McGauran's joint press release, May 13, 2003 (See http://www.dest.gov.au/ministers/nelson/budget03/Table3.pdf)
2. These figures are Allen Consulting Group estimates
3. The National Competitive Grants Program (NCGP) includes the Discovery and Linkage Grant Programs, which are described in section A8.

In addition, there are three major scientific research-performing agencies in the Education, Science and Training Portfolio. These are the Commonwealth Scientific and Industrial Research Organisation (CSIRO), the Australian Nuclear Science and Technology Organisation (ANSTO) and the Australian Institute of Marine Science (AIMS). International expenditures by these agencies are summarised in Table A2 and discussed later in this Appendix.

Table A2

RESEARCH PERFORMING AGENCIES INVOLVEMENT IN INTERNATIONAL S&T

Agency	*Year*	*Commonwealth S&T Expenditure*	*International S&T Expenditure Analysed*
CSIRO	2001-2	$509.6m	(1)
ANSTO	2001-2	$152.4m	$6,118,932
AIMS	2001-2	$19.6m	$345,385 (2)

Source: The Allen Consulting Group
Notes: 1. CSIRO expenditure has not been analysed. See Section A9 for an estimate of this figure.
2. Estimate provided by AIMS

DEST provides grants in support of international science and technology activities directly under a set of Departmental Programmes including the Innovation Access Programme (IAP – International S&T), Major National Research Facilities (MNRF), the Cooperative Research Centres (CRC), as well as fellowships, scholarships and other awards. The contribution each of these make to international S&T collaboration is discussed below.

A1 Innovation Access Programme – International S&T

The goal of the Innovation Access Programme – International S&T (IAP-IST) is to promote innovation by increasing Australian access to global research and technologies. The budgeted expenditure for 2002-3 was $7.65m, on three main categories of activity.

- Strategic Policy activities, including:
  - Innovation Access fora;
  - Bilateral S&T Agreements;
  - the Global Cooperation Programme; and
  - Showcasing Australian S&T.
- Competitive grants to researchers.
- Outsourced Components.
  - International Science and Technology Networks (ISTN), outsourced to the Academy of Science (AAS), the Academy of Technological Science and Engineering (ASTE) and Engineers Australia.
  - Access to major research facilities (AMRF), outsourced to the Australian Nuclear Science and Technology Organisation.
  - Access to European Centre for High Energy Physics (CERN), outsourced to the Australian Institute for High Energy Physics (AUSHEPC).

The IAP replaced the Technology Diffusion Program in July 2001. The year 2001-2 was atypical, with lower than usual level of grants because the Program was split when the science function was moved to DEST and IAP-IST was established. For this reason, the analysis of the Competitive Grants component is based on the year 2002-3. All expenditure under the IAP-IST Programme is classified as international S&T. IAP-IST expenditures are summarised in Table A3 and analysed in this Appendix. Other elements of the IAP, delivered by DITR and NOIE are not included in this analysis.

A1.1 Strategic Policy

Under the Strategic Policy component of the IAP–IST, DEST initiates activities to promote the development of bilateral and multilateral international S&T activities. These are often multilateral, country-specific or technology specific in their focus. This Programme has four components:

- support for innovation access fora;
- activities associated with bilateral S&T agreements;

- funding to underpin Australia's participation in multilateral fora such as the OECD's Global Science Forum; and
- Showcasing Australian S&T.

A variety of activities are included in this Programme. For the first two subcategories, for example, most of the funds were used to finance conferences and workshops.

Table A3

INNOVATION ACCESS PROGRAMME – INTERNATIONAL S&T

Activity	*Year*	*Commonwealth S&T Expenditure (1) ($'000)*	*International S&T Expenditure Analysed ($'000)*
Strategic Policy	**2001-2 & 2002-3**	**1,640**	**1,630**
Innovation Access Fora		630	610
Bilateral Agreements		520	558
Global Cooperation Programme		130	138
Showcasing Australian S&T		360	324 (2)
Competitive Grants	**2002-3**	4,290	3,500
General Grants (EU Framework Funds & Conferences)		3,920	3,113
Australia-China Special Fund for S&T Cooperation		230	250
Australia-Korea Industrial Technology Cooperation Fund		140	137
Outsourced Components	**2001-2**	1,820	1,591
International S&T Networks (ISTN)		1,100	891
– Fellowships and Awards (AAS)		790	500
– Missions and Workshops (ASTE)		310	291
– International Conference Support Scheme & Oliphant conference series		0(3)	100
Access to Major Research Facilities (AMRF)		520	500
Access to High Energy Physics Facilities (AHEPF)		200	200
Total		***$7,750***	***$6,721***

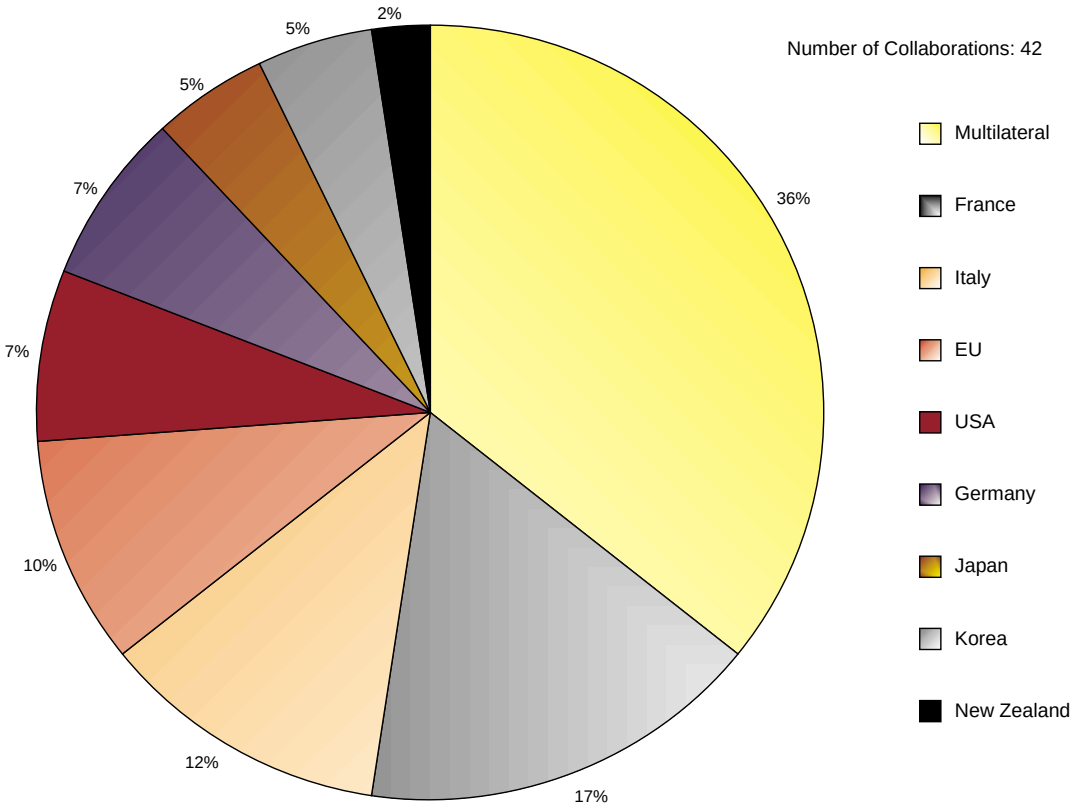
Source: The Allen Consulting Group
Notes: 1. Amounts reported in this column were provided by DEST
2. Funding for Showcasing is shared with DITR, which also allocated $323,550 to the program in 2001-2 (ie the total international expenditure for this program was $647,100 in 2001-2).
3. These funds were sourced from an earlier year.

A1.1.1 Analysis

The analysis of the four component programs in Strategic Policy (comprising 40 projects in 2002-3) is shown in Figures A1 to A5 (Note: the collaborations and $323,550 of expenditure, contributed by DITR to Showcasing is included in this analysis). In the first instance, Figure A1, over a third of collaborations were multilateral, indicating a high degree of participation in multilateral fora. Additionally, 46 per cent of remaining collaborations were conducted within Europe, namely with France, Italy, the EU and Germany. Only 10 per cent of collaborations were located in Asia (Japan and Korea) and 7 per cent in the US.

Figure A1

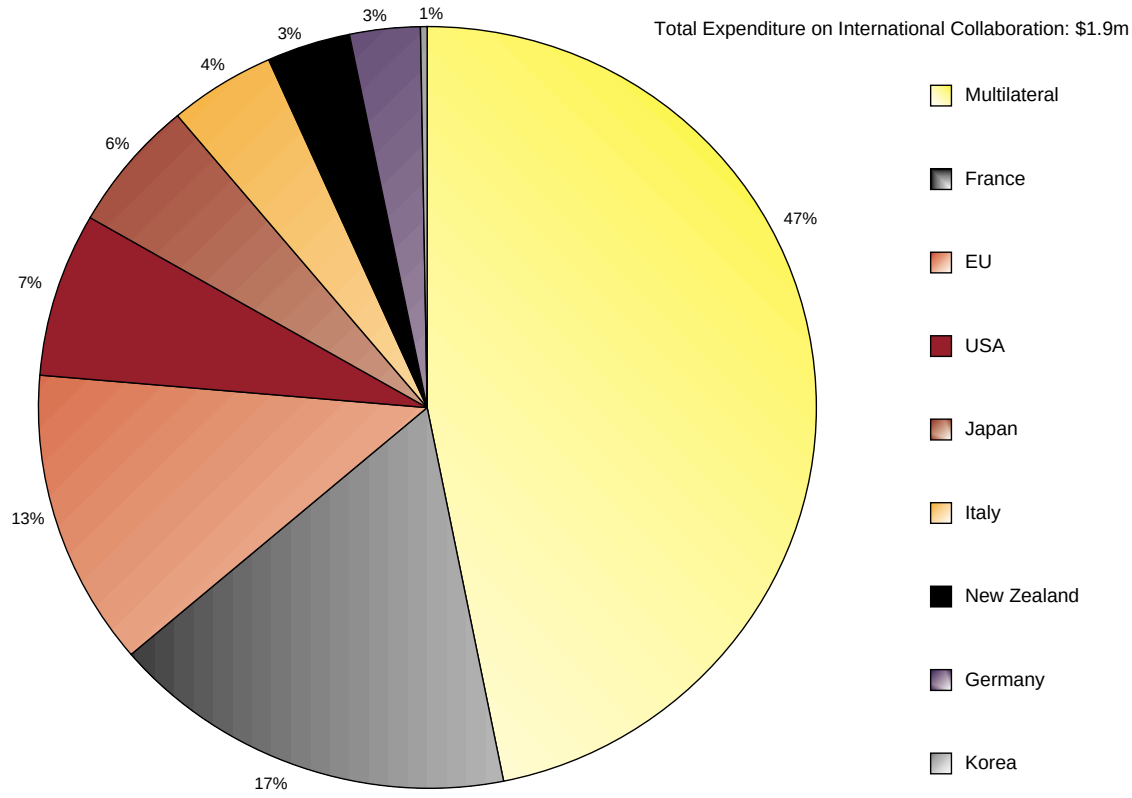
IAP-IST STRATEGIC POLICY – COLLABORATIONS BY COUNTRY



Source: The Allen Consulting Group

Figure A2

IAP-IST STRATEGIC POLICY – EXPENDITURE BY COUNTRY



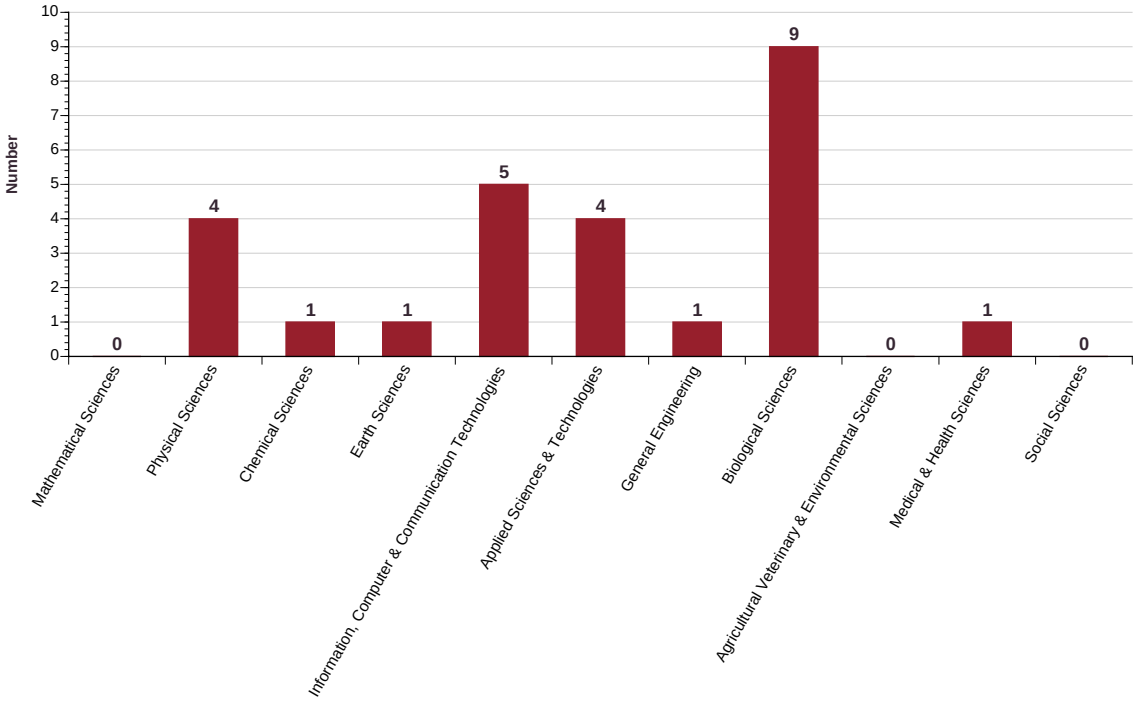
Source: The Allen Consulting Group
Note: The total amount of funding characterised in this figure includes $340,000 from DIST for the Showcasing Programme. For this reason the total expenditure on Strategic Policy ($1.9m) in this figure is greater than the total for DEST's expenditure on Strategic Policy shown in Table A3.

In terms of expenditure on international activities (see Figure A2) almost half of all expenditure was multilateral. This finding is due, to a large extent, to the $0.66m of expenditure on Showcasing being primarily spent on multilateral showcasing events. Another 43 per cent of expenditure was distributed in Europe (ie, France, the EU, Italy and Germany). It thus appears that Strategic Policy is primarily targeting multilateral fora, and reinforcing Australian collaborations among traditional S&T collaborative partners in country-specific fora.

The international activities encompassed within Strategic Policy involve all but three fields of research, with Biological Sciences being the most common, followed by Information, Computer & Communication Technologies, Applied Sciences & Technologies, and Physical Sciences (see Figure A3).

Figure A3

IAP-IST STRATEGIC POLICY – ACTIVITIES BY FIELD OF RESEARCH



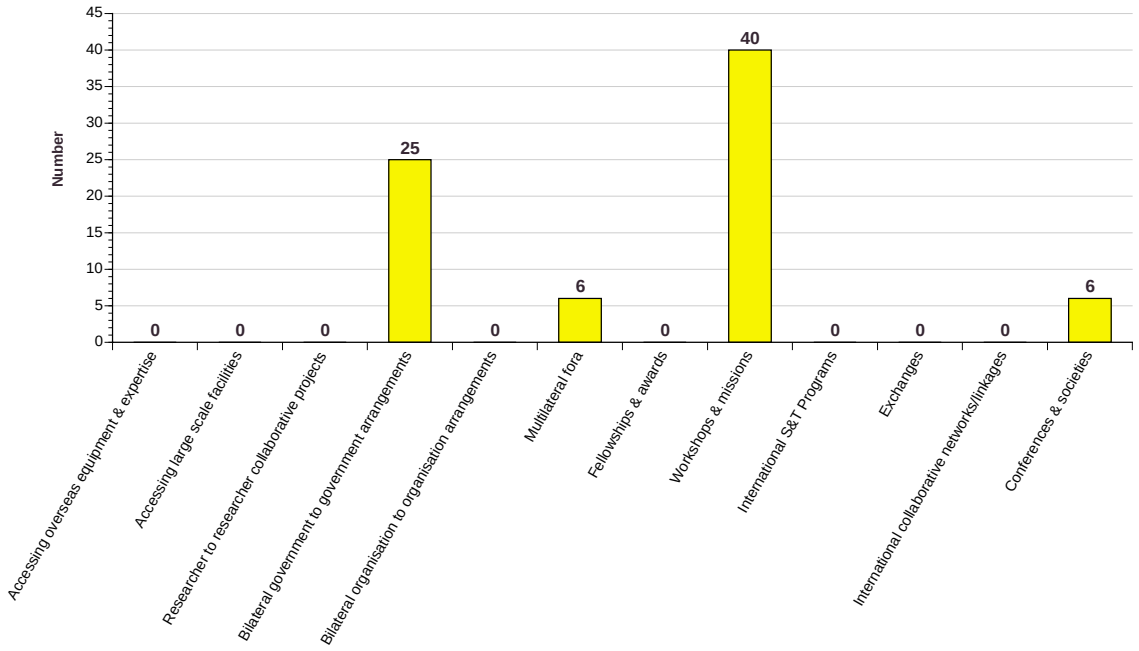
Source: The Allen Consulting Group

The findings for purpose and type of activities are in keeping with the objectives of Strategic Policy. Figure A4 clearly illustrates a dominance of workshops and missions, followed by bilateral government-to-government arrangements. Strategic Policy is also responsible for DEST' contribution to Australia's membership of the Global Biodiversity Information Facility (GBIF) (an annual fee of $100,000 shared equally over a five year membership period among DEST, Environment Australia, CSIRO, ARC and NHMRC).

Data on the geographic location of researchers in Australia is shown in Figure A5. Here, people involved with Showcasing were primarily located in metropolitan regions of Victoria and New South Wales. On the other hand, those located in the ACT primarily represent involvement in the International Bilateral S&T Agreements element of Strategic Policy. It is not possible to give a full picture of the geographic location of collaborators involved in this type of program. Many people from a range of locations participate in Strategic Policy events or projects whereas these data only represent a single location for each function.

Figure A4

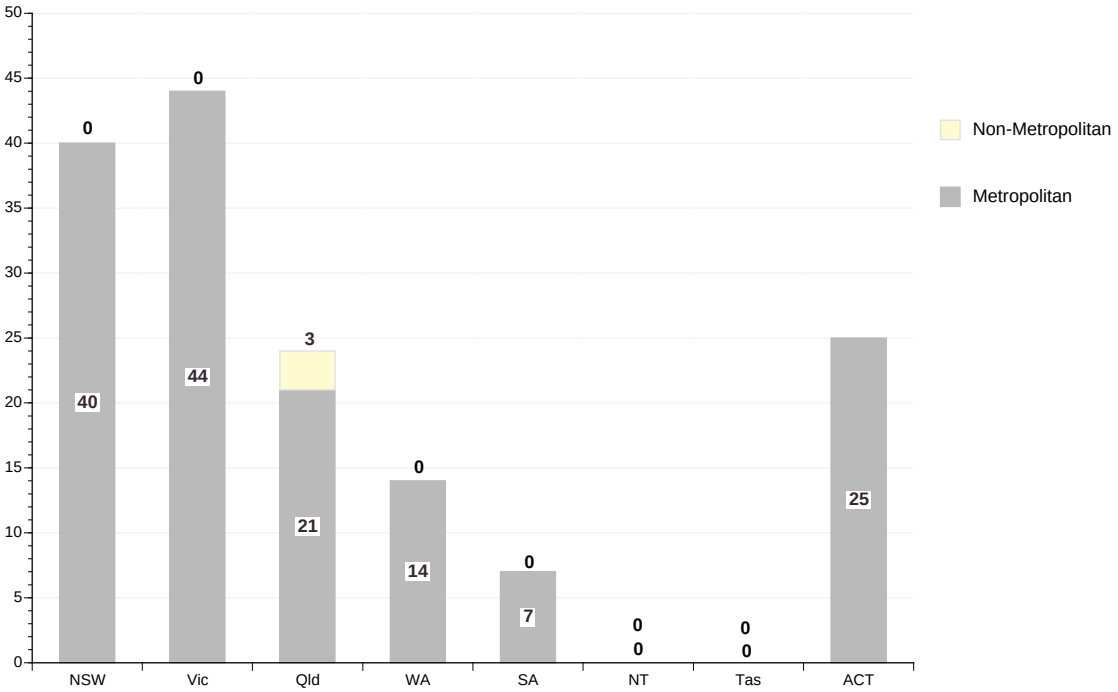
IAP-IST STRATEGIC POLICY – ACTIVITIES BY PURPOSE AND TYPE



Source: The Allen Consulting Group

Figure A5

IAP-IST STRATEGIC POLICY, SHOWCASING – RESEARCHERS BY GEOGRAPHIC LOCATION



Source: The Allen Consulting Group

A1.2 Competitive Grants to Researchers

The Competitive Grants component of IAP–IST provides support to Australian researchers to undertake international S&T activities, such as R&D collaborations, alliances, project-specific workshops and conferences.

Grants are designed to add value to and not fully reimburse the costs of S&T activities. Accordingly, support is available up to a maximum of 50 per cent of the Australian component of eligible project costs and must not duplicate support

available from other Commonwealth Government forms of assistance, for example the ARC or NHMRC.

Applicants *must* provide evidence of the level and parameters of support from their international partner(s) in order to be eligible for a grant. In other words, Competitive Grants are primarily designed to support established collaborations as opposed to the development of entirely new networks and linkages. The information contained in grant applications thus gives an additional insight into the types of international relationships that support Australian S&T. For this reason, grant applications have been included, as well as successful grants, in the analysis of this program.

As indicated in Table A3, Competitive Grants are administered via a number of different funding arrangements. General Competitive Grants are awarded to researchers on a competitive basis for international S&T collaboration with APEC, EU and other nations, with three selection rounds per financial year.

Up to $750,000 per annum is provided for Australian participation in European Union Framework research projects (although more funds may become available depending upon the scientific merits of applications) and funds of up to $50,000 are also available for major international conferences (between 2 and 5 per annum) to be hosted in Australia. These conferences are distinct from the Oliphant conferences discussed in A2.1.6.

Two separate funds cater to Competitive Grants for collaboration with Korea (the Australia-Korea Industrial Technology Cooperation Fund) and with China (the Australia-China Special Fund for S&T cooperation), each of which is administered with respective national governments.

A1.2.1 Analysis

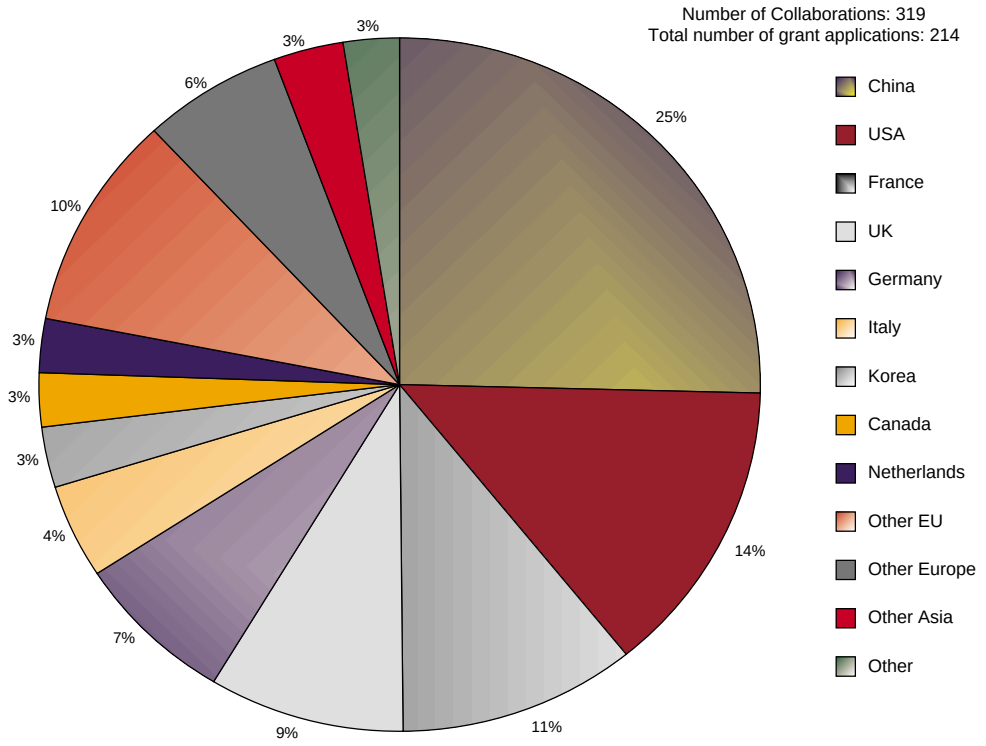
In 2002-3, altogether the Competitive Grants Programme received 214 applications and awarded 42 grants. Figures A6 to A8 show the distribution of countries and economies involved in international collaborations with Australian researchers applying for and receiving Competitive Grants. Collaborations were calculated by counting the number of collaborating countries/economies (and where appropriate, the number of collaborating organisations per country) listed in each grant application.

It is clear from these figures that the demand for funds for established international collaborative research strongly outweighs the supply of grants. The distribution of collaborations by countries/economies applying for grants involves 33 different nations, and encompass 319 collaborations (see Figure A6). The actual number of collaborations that received funding is 81, i.e. for the 42 grants awarded. Predictably, nations with a tradition of S&T collaboration with Australia, such as the UK, US, France and Germany, were well represented for both applications and awarded grants (see Figure A7). Along with China, these nations represent over half of the total collaborations in both instances.

The Australia-China Special Fund accounts for the apparent high demand for grants with China for S&T Cooperation, which received 75 grant applications and awarded 13 grants. It also suggests a strong interest in the rapidly developing S&T activities in this major economy. Grant applications to the Australia-China Special Fund outnumber the 36 grant applications to the EU Framework Fund and 5 grant applications to the Australia-Korea Industrial Technology Cooperation Fund. Korea has more collaborations than Japan.

Figure A6

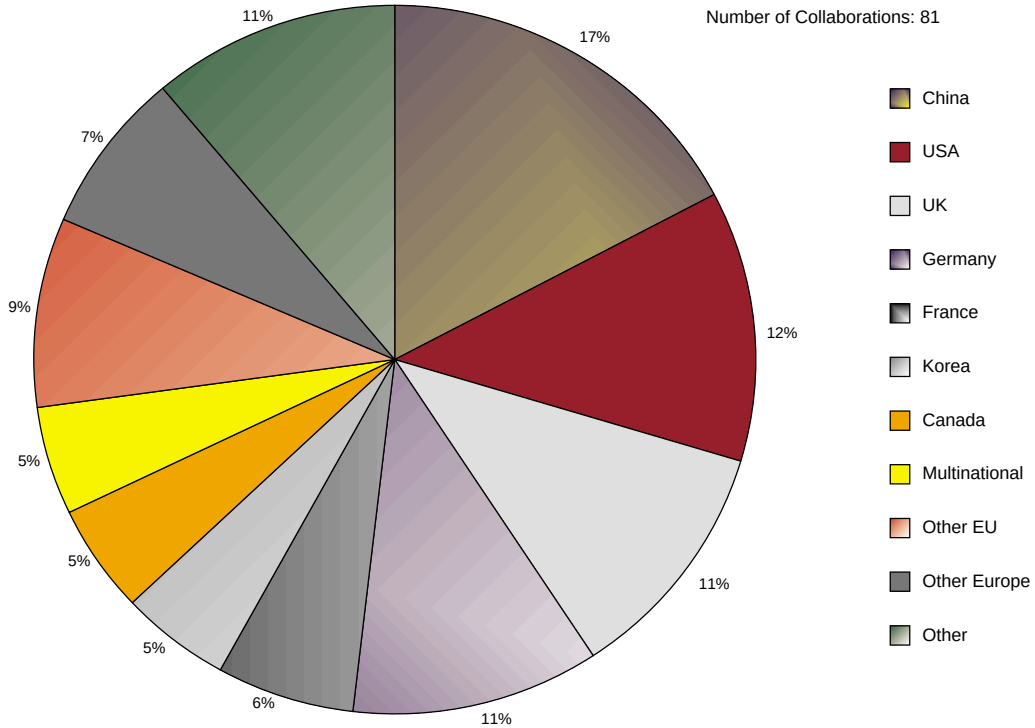
IAP-IST COMPETITIVE GRANTS APPLICATIONS – COLLABORATIONS BY COUNTRY/ECONOMY



Source: The Allen Consulting Group
Notes: 1. **Other EU**: Belgium, Spain, Austria, Finland, Sweden
2. **Other Europe**: Switzerland, Finland, Norway, Czech Republic, Hungary, Turkey, Poland, Slovakia, Slovenia
3. **Other Asia**: Japan, Singapore, Taiwan, India, Malaysia
4. **Other**: Mexico, New Zealand, South Africa, Brazil, Senegal

Figure A7

IAP-IST COMPETITIVE GRANTS – COLLABORATIONS BY COUNTRY

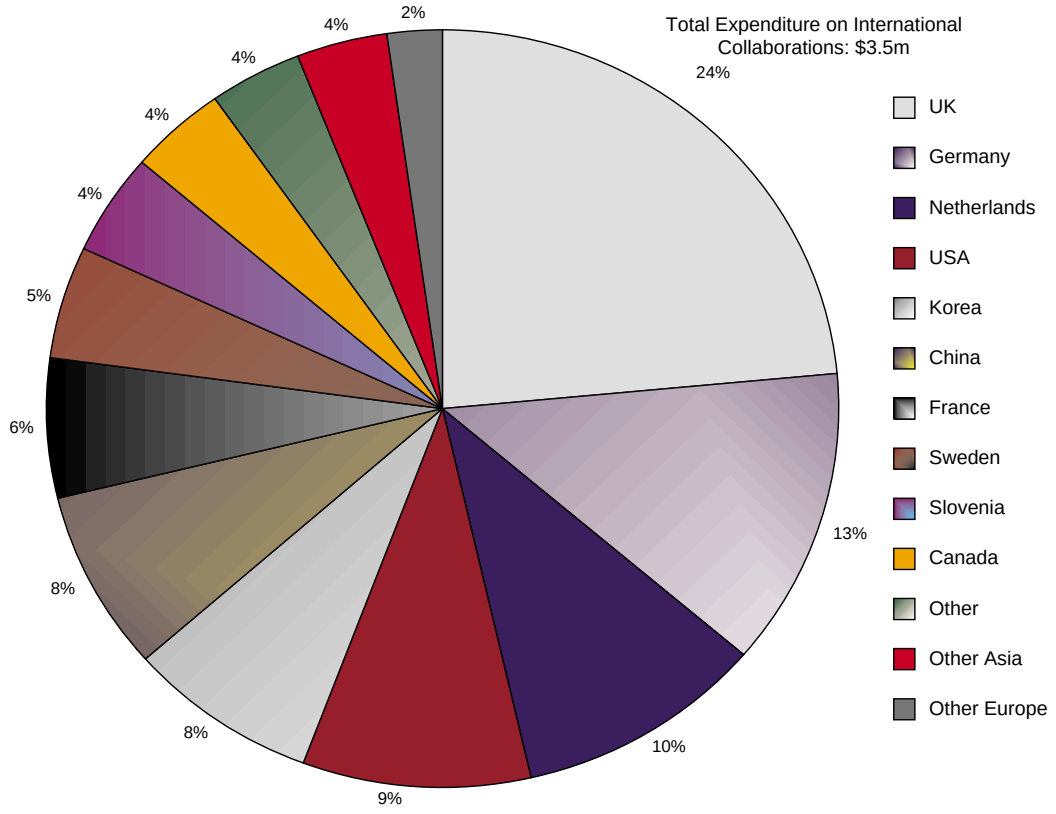


Source: The Allen Consulting Group
Notes: 1. **Other EU**: Netherlands, Sweden, Belgium, Italy
2. **Other Europe**: Norway, Czech Republic, Slovenia, Slovakia, Poland
3. **Other**: Singapore, New Zealand, Japan, Malaysia, Mexico, Senegal, Thailand

In terms of expenditure by countries/economies awarded competitive grants, the distribution of grant funds reflects Australia's traditional S&T collaboration patterns; European nations rank highest, followed by the US, Korea and China (see Figure A6). It should be noted, however, that expenditure in the UK and Germany was inflated by an unusual EU Framework Fund grant worth $750k. Expenditure on Korean collaborations through the Australia-Korea Fund only amounted to $137k but was supplemented by funds from General Collaborative Grants. Again, collaborations involving Korea have attracted more funds than Japan.

Figure A8

IAP-IST COMPETITIVE GRANTS – EXPENDITURE BY COUNTRY

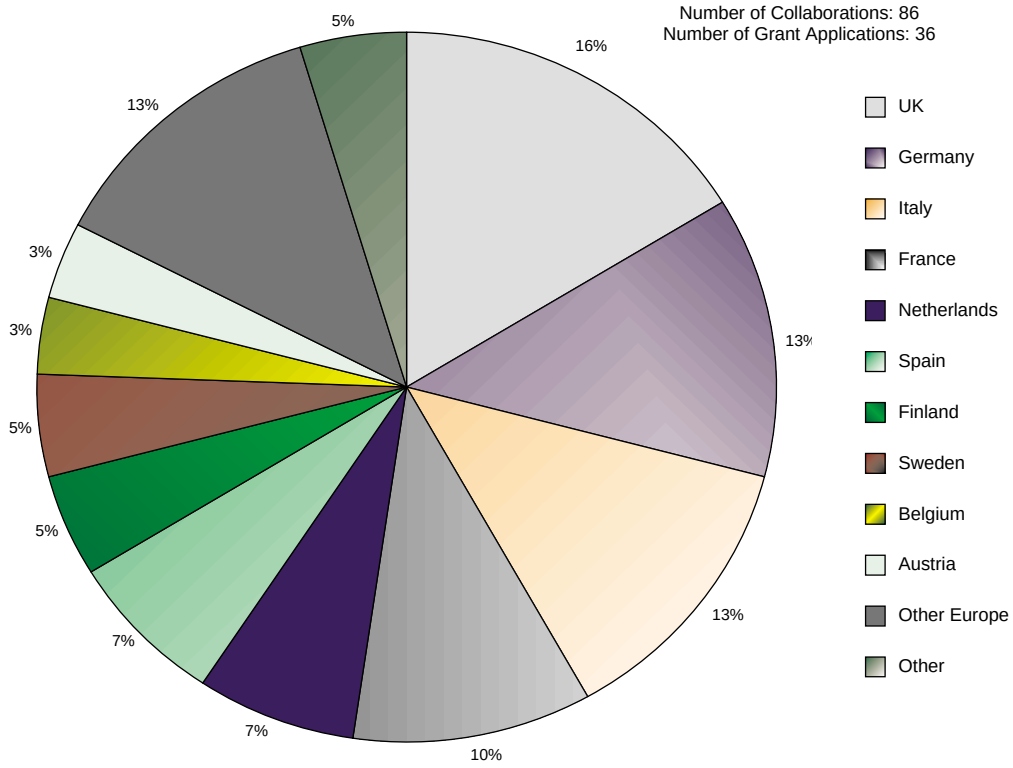


Source: The Allen Consulting Group
Notes: 1. **Other**: Multinational, Mexico, New Zealand, Senegal
2. **Other Asia**: Malaysia, Singapore, Thailand, Japan
3. **Other Europe**: Italy, Norway, Czech Republic, Slovakia, Poland, Belgium

An additional analysis on the distribution of collaborations among countries applying for and receiving funds from the EU Framework Fund is provided in Figures A9 to A11. Again the demand for funding for existing collaborations is greater than the supply of grants, with only 6 grants awarded from 36 applications. Diverse mixes of 22 nations, including nations outside of Europe, were participating in collaborations listed on grant applications (see Figure A9). It appears that project applications involving the UK and Germany were particularly successful. The UK highest-ranking position at 16 per cent of collaborations in grant applications (see Figure A9), increased to 27 per cent of collaborations in EU Framework grants (see Figure A10) and 38 per cent of expenditure (see Figure A11). In the case of Germany, its second ranking position of 13 per cent of EU Framework grant applications increased to 23 per cent of grant collaborations and 24 per cent of expenditure. Over half of the collaborations awarded grants and almost three quarters of expenditures were located in the UK and Germany. The dominance of the UK, Germany and to a lesser extent Slovenia and the Netherlands, in expenditure on collaborations is a reflection of the single $750k grant mentioned above (see Figure A11).

Figure A9

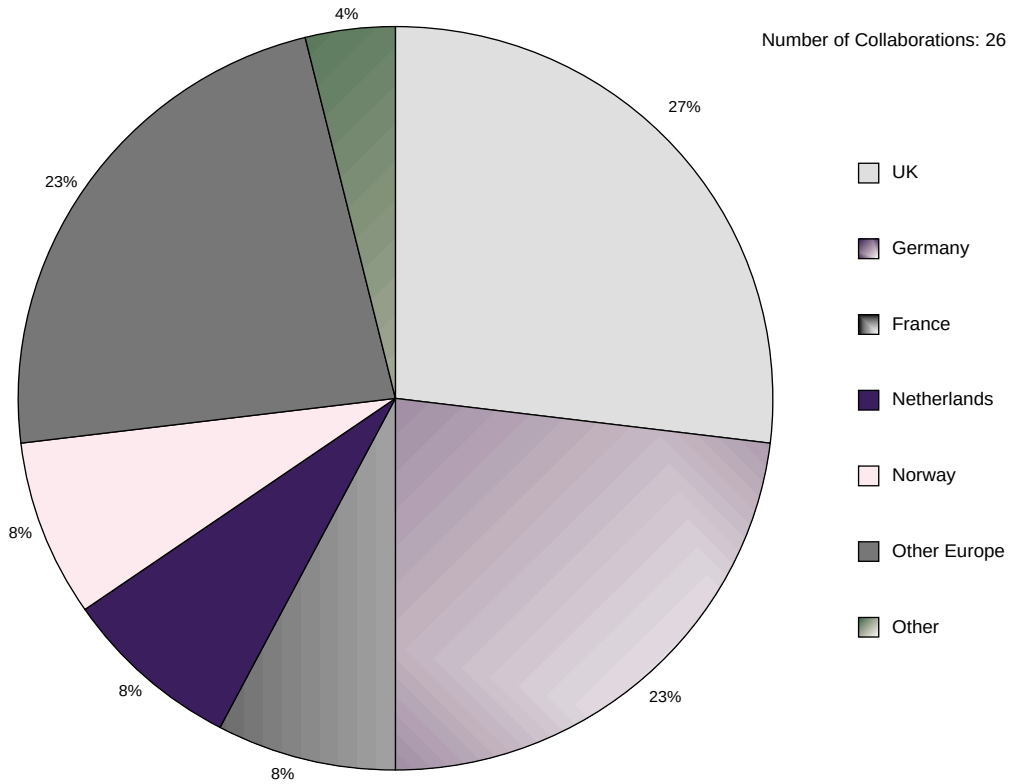
IAP-IST EU FRAMEWORK FUNDS COMPETITIVE GRANT APPLICATIONS – COLLABORATIONS BY COUNTRY



Source: The Allen Consulting Group
Notes: 1. **Other Europe**: Switzerland, Norway, Czech Republic, Hungary, Turkey, Gibraltar, Slovenia, Slovakia, Poland
2. **Other**: US, Mexico, China

Figure A10

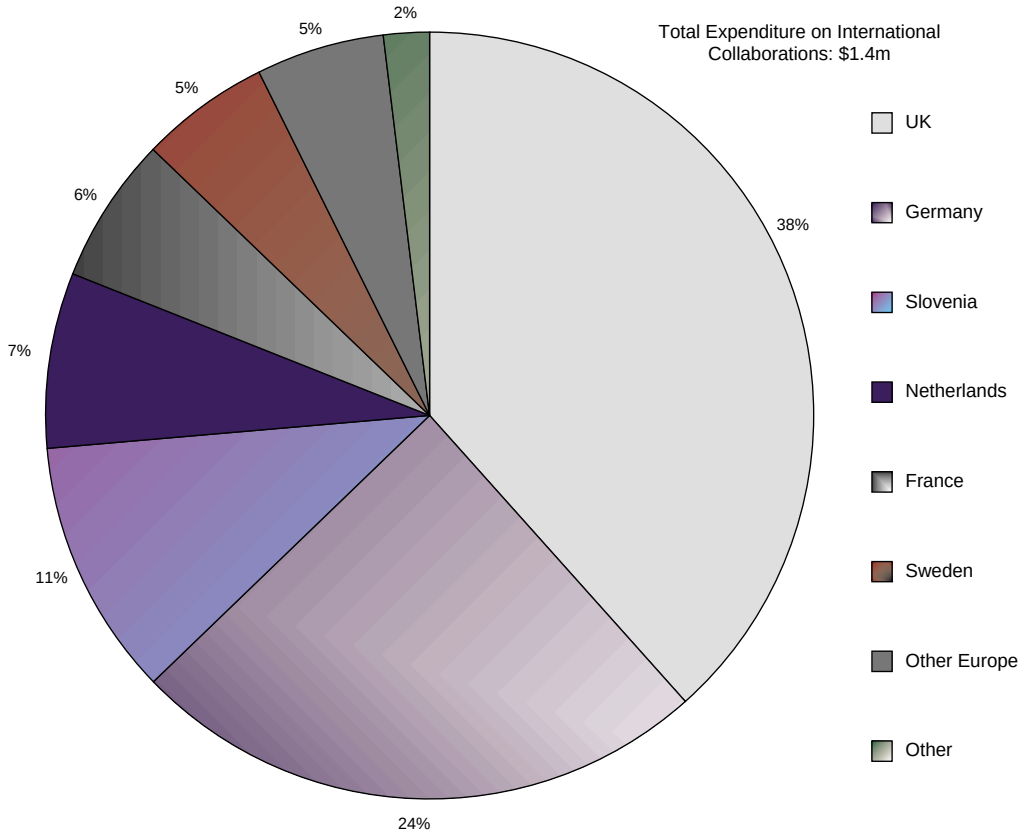
IAP-IST EU FRAMEWORK FUNDS COMPETITIVE GRANTS – COLLABORATIONS BY COUNTRY



Source: The Allen Consulting Group
Notes: 1. **Other Europe**: Czech Republic, Italy, Poland, Sweden, Slovakia, Slovenia
2. **Other**: Mexico

Figure A11

IAP-IST EU FRAMEWORK FUNDS COMPETITIVE GRANTS – EXPENDITURE BY COUNTRY



Source: The Allen Consulting Group
Notes: 1. **Other Europe**: Italy, Norway, Czech Republic, Slovakia, Poland
2. **Other**: Mexico

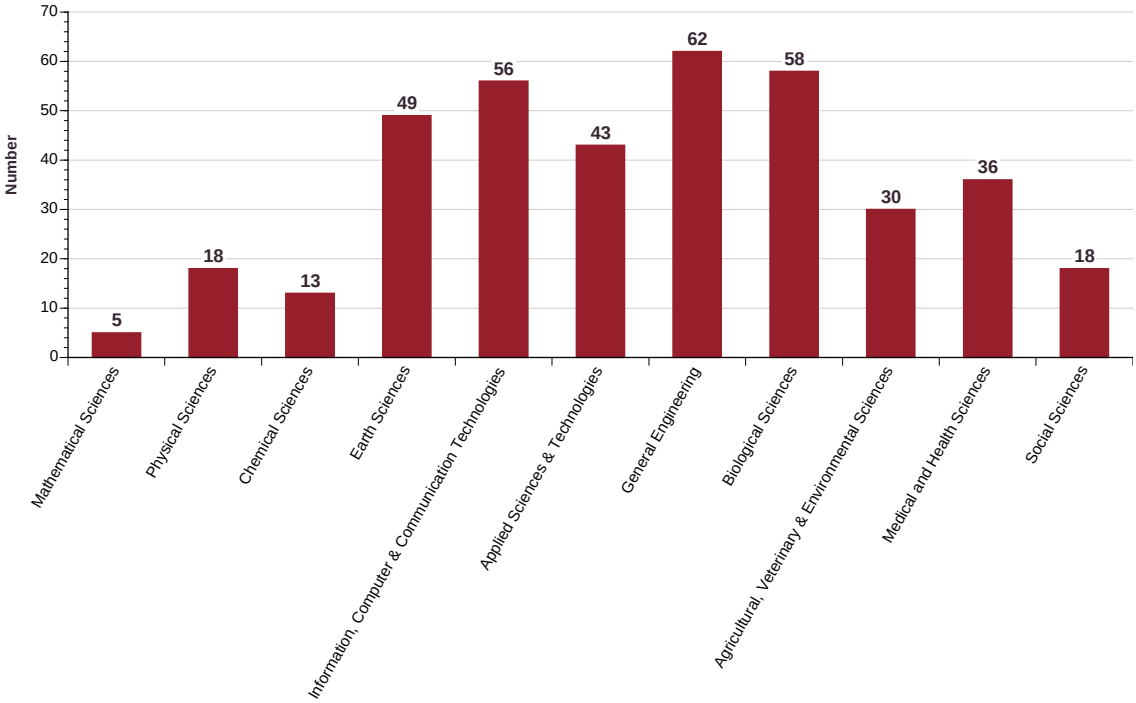
The analysis of Competitive Grant applications and awards by field of research (FOR) is contained in Figures A12 and A13. The FOR calculation for this program differs as the Competitive Grants data-set provided contained multiple research fields per S&T project, as opposed to a single overriding FOR per project. As it was not clear which single FOR could be allocated per project, multiple fields were counted and contributed equally to the overall distribution of FOR for the program.

The pure Mathematical, Physical, Chemical Sciences and Social Sciences appear less common than other FORs in grant applications. The more 'applied' FORs such as General Engineering, Applied Sciences & Technologies and Information, Computer & Communication Technologies, ranked strongly.

Many individual projects combined Earth Science or Biological Science with the latter more 'applied' FORs. The distribution of FORs for successful grants shows Earth and Biological Sciences to be most common, with what appears to be a drop in the 'applied' FORs described above.

Figure A12

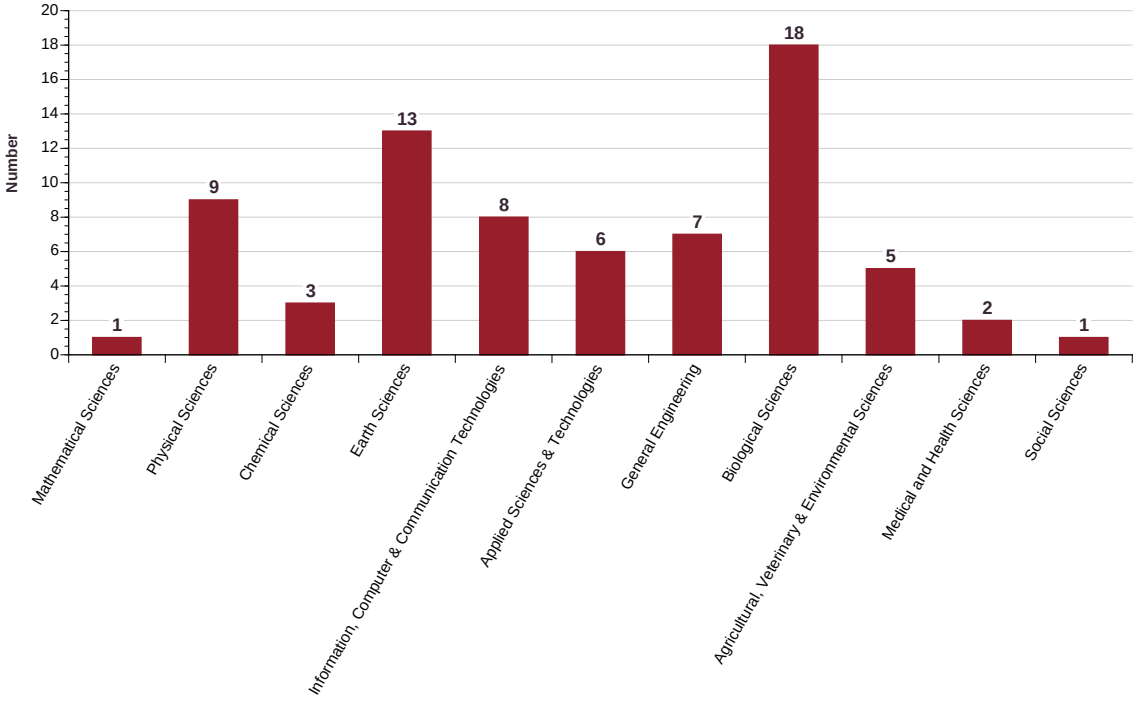
IAP-IST COMPETITIVE GRANT APPLICATIONS – ACTIVITIES BY FIELD OF RESEARCH



Source: The Allen Consulting Group

Figure A13

IAP-IST COMPETITIVE GRANTS – ACTIVITIES BY FIELD OF RESEARCH

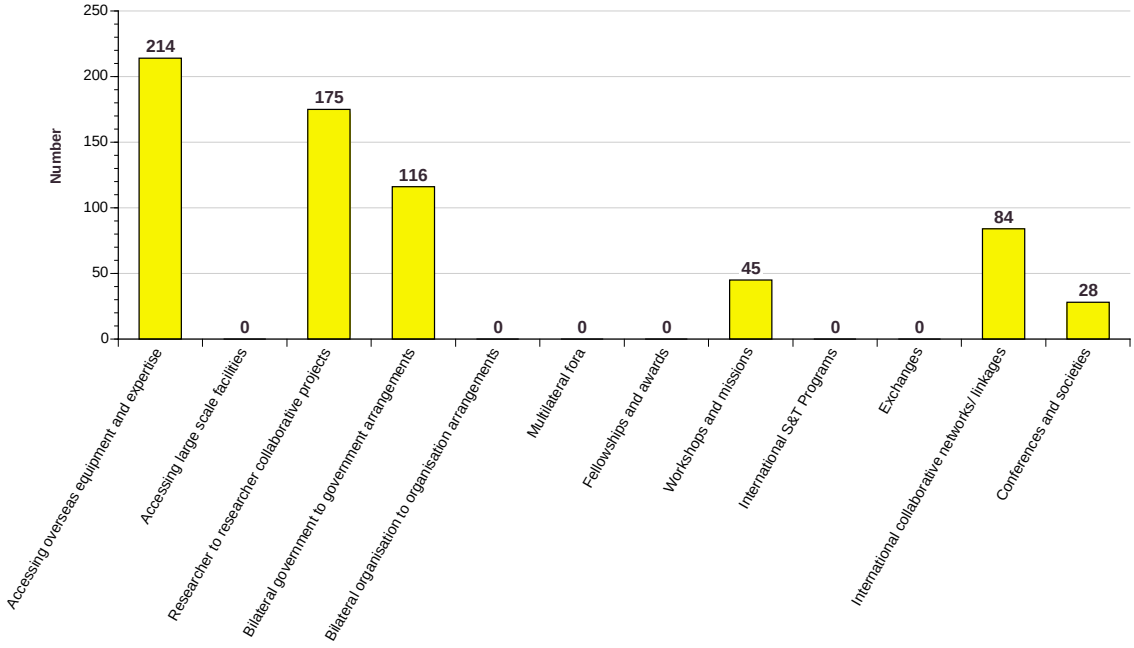


Source: The Allen Consulting Group

As expected, the most common purpose for applications and grants was 'accessing overseas equipment and expertise' and 'researcher to researcher collaborative projects' (see Figures A14 and A15). This demonstrates that the Competitive Grants element of IAP-IST is essentially funding established collaborative research, while allowing a relatively small proportion of funding to support other collaborative activities such as alliances, workshops, conferences and bringing experts to Australia. The 'bilateral government to government arrangements' represent the specific competitive grants schemes offered by the EU, China and Korea.

Figure A14

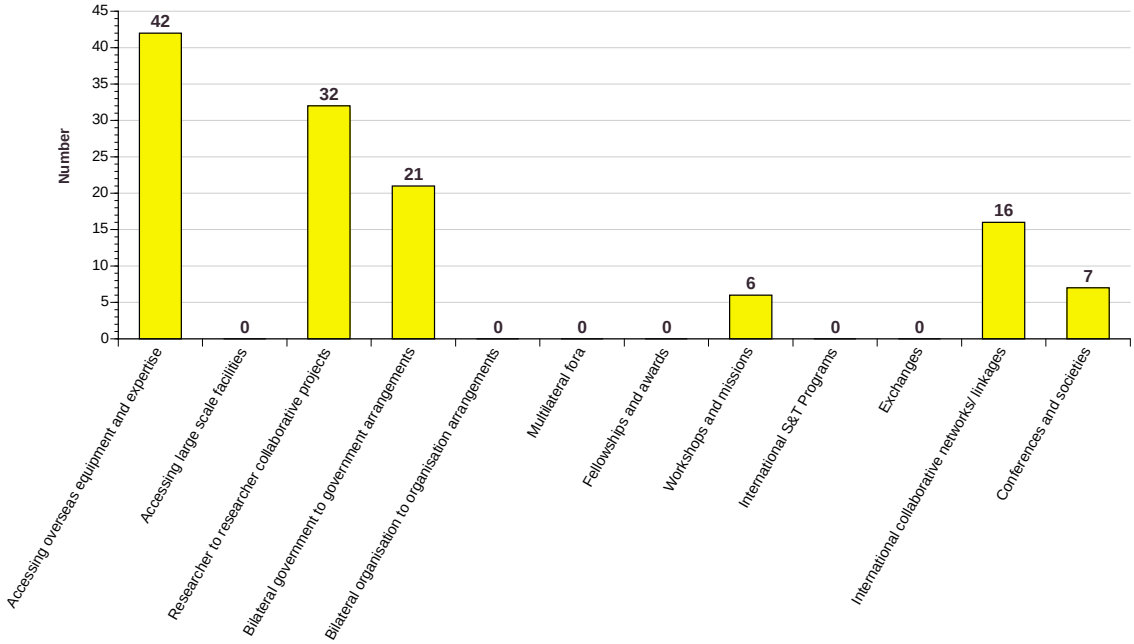
IAP-IST COMPETITIVE GRANT APPLICATIONS – ACTIVITIES BY PURPOSE AND TYPE



Source: The Allen Consulting Group

Figure A15

IAP-IST COMPETITIVE GRANTS – ACTIVITIES BY PURPOSE AND TYPE

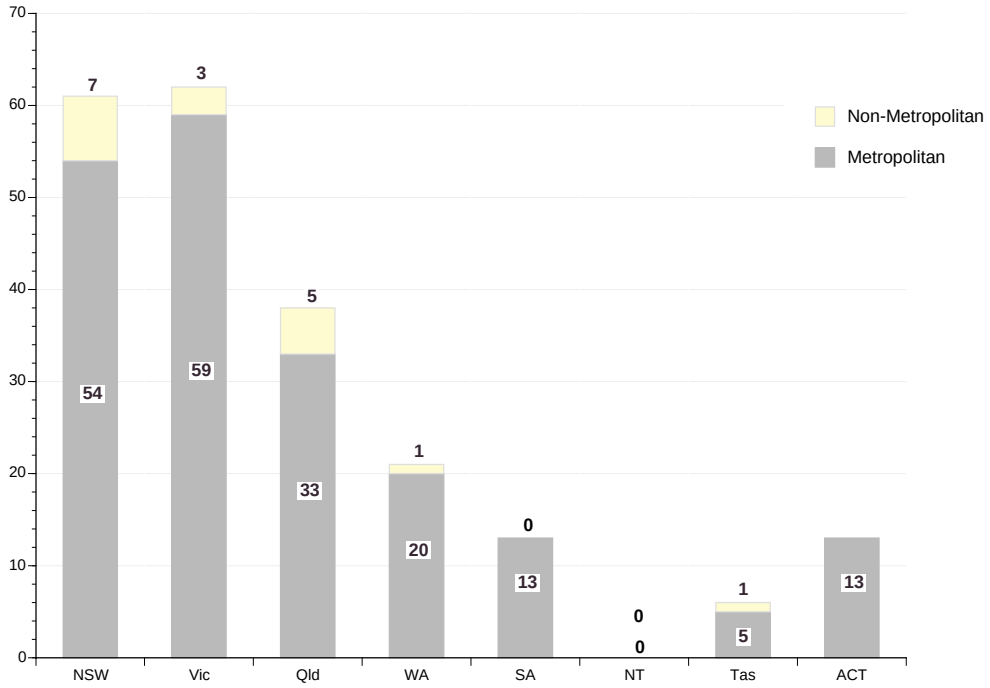


Source: The Allen Consulting Group

Researchers in the metropolitan regions of Victoria, NSW and Queensland made the majority of grant applications respectively (see Figures A16 and A17). This distribution is repeated for grant recipients, although it appears that proportionally fewer grants were awarded to applicants from NSW than were awarded to applicants from elsewhere in the country. New South Wales and Queensland have the highest proportions of regional research activity, which explains why regional applications are highest in these states. Ten per cent of grants went to researchers from regional Australia.

Figure A16

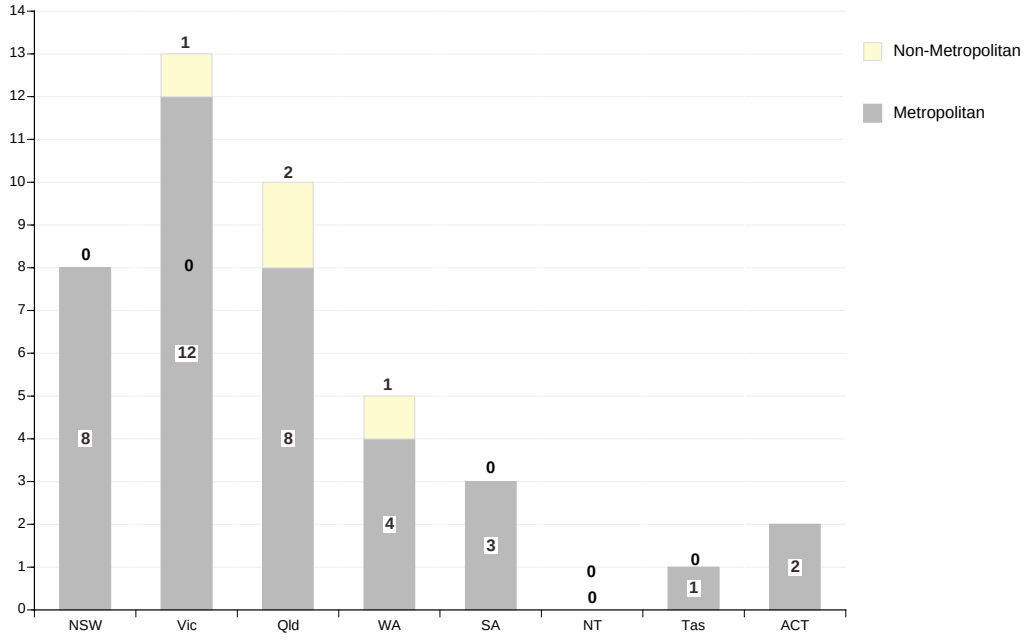
IAP-IST COMPETITIVE GRANT APPLICATIONS – RESEARCHERS BY GEOGRAPHIC LOCATION



Source: The Allen Consulting Group

Figure A17

IAP-IST COMPETITIVE GRANTS – RESEARCHERS BY GEOGRAPHIC LOCATION



Source: The Allen Consulting Group

A1.3 Outsourced Components

There are several elements of IAP-IST, which are outsourced. They are summarised in Table A4.

Table A4

IAP-IST - OUTSOURCED COMPONENTS

Component	*Year*	*International Expenditure Commonwealth Share Analysed*
International S&T Networks	2001-2	$791,580
Access to Major Research Facilities	2002-3	$500,000
Access to High Energy Physics	2001-2	$216,526

Source: The Allen Consulting Group and material provided by DEST and the administering organisations

A1.3.1 International Science and Technology Networks

The Australian Academy of Science (AAS), the Australian Academy of Technological Sciences and Engineering (ASTE) and Engineers Australia (formerly the Institution of Engineers) jointly deliver the International Science and Technology Networks (ISTN), a component of IAP-IST (see Table A5). The ISTN has an overall aim of improving Australian access to the international scientific arena and increasing international awareness of Australian research expertise. The two Academies and Engineers Australia have different but complementary approaches in their delivery of the ISTN component, these are described below. The analysis of the ISTN shown in Figures A18 to A21 was drawn from the international activities of the two academies, i.e. 'fellowships and awards' run by the AAS and 'missions and workshops' run by the ASTE.

Table A5

IAP-IST – INTERNATIONAL SCIENCE AND TECHNOLOGY NETWORKS (ISTN)

Organisation	*Year*	*International S&T Expenditure Commonwealth Share Analysed ($ thousands)*
AAS: International Exchanges Fellowships and Awards	2001-02	
North East Asia	"	$220,000*
Europe	"	$140,000*
North America	"	$140,000*
ASTE: Missions and Workshops	2001-02	$291,500*
Engineers Australia, AAS & ASTE: Sir Mark Oliphant Conference Series	2002-03	$100,000
TOTAL	2001-02	$791,500

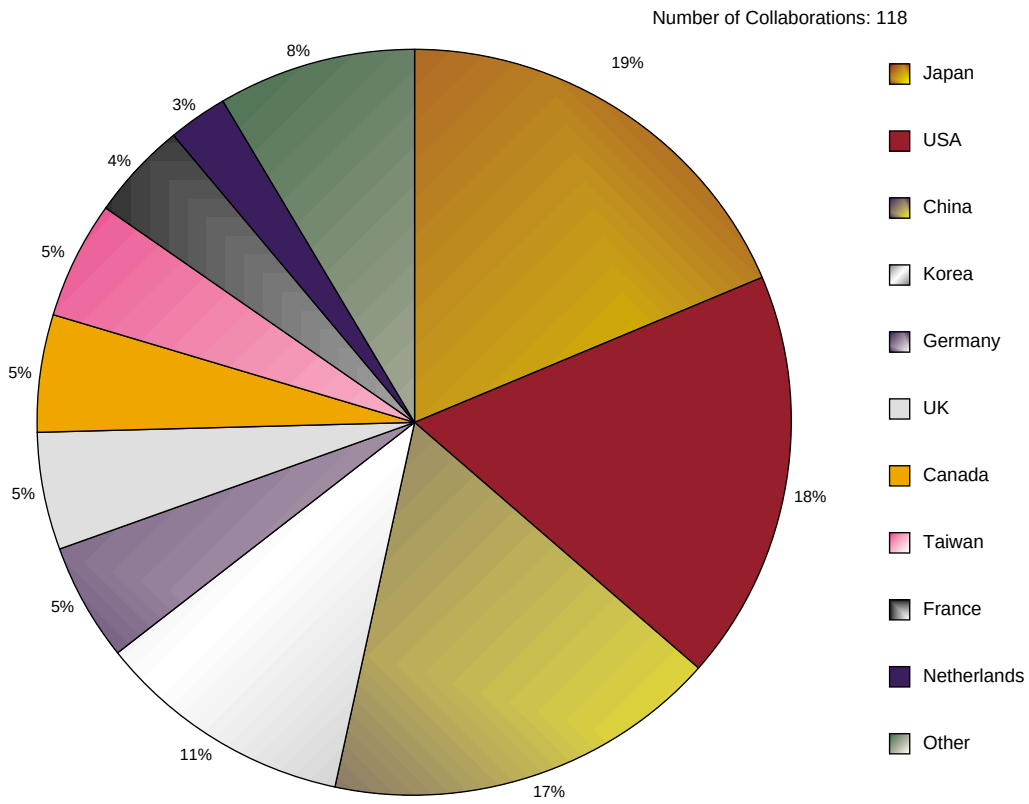
Source: The Allen Consulting Group and material provided by the representative organisations
Note: *ACG estimates that do not include program delivery costs or commitments for 2002-03

Analysis

Figure A18 shows that half of the ISTN international activities were located in Asia, with the remainder distributed evenly between Europe and the Americas. Nineteen percent of collaborations were with Japan, 18 percent with the US and 17 per cent with China. A similar pattern of regional distribution is seen in Figure A19 for the expenditure on these international activities, with Japan's proportion increasing to 25 per cent.

Figure A18

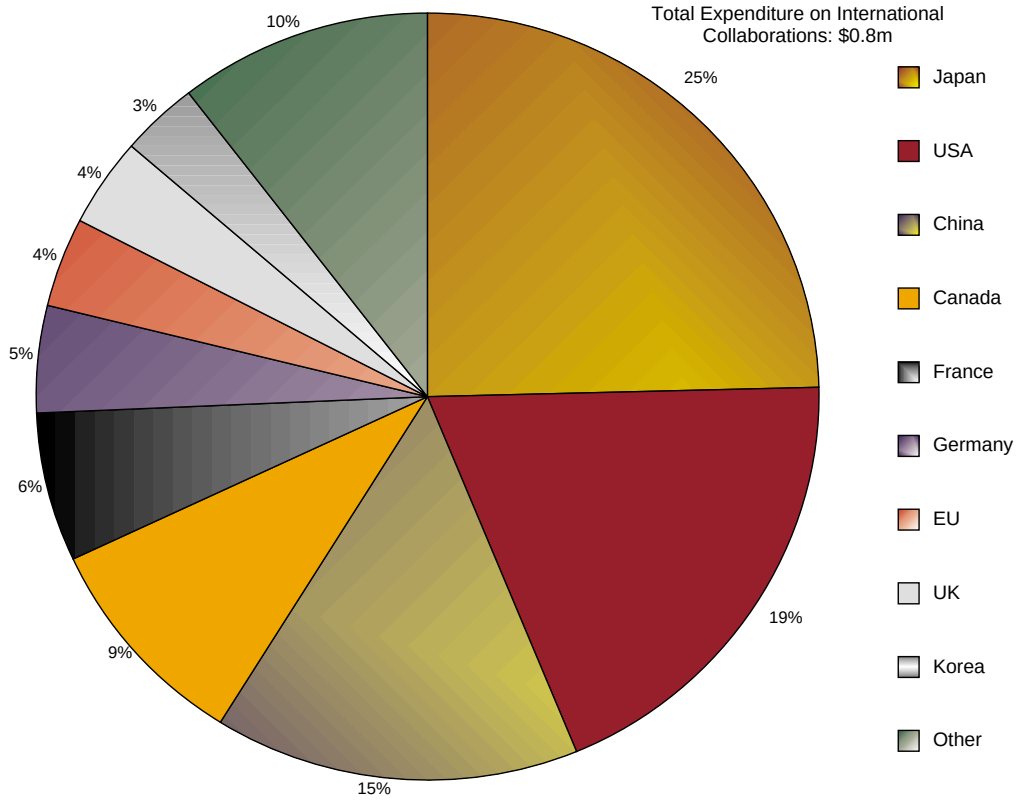
IAP-IST ISTN – ACTIVITIES BY COUNTRY/ECONOMY



Source: The Allen Consulting Group
Note: **Other**: Denmark, EU, Greece, Mexico, Italy, Sweden

Figure A19

IAP-IST ISTN – EXPENDITURE BY COUNTRY/ECONOMY

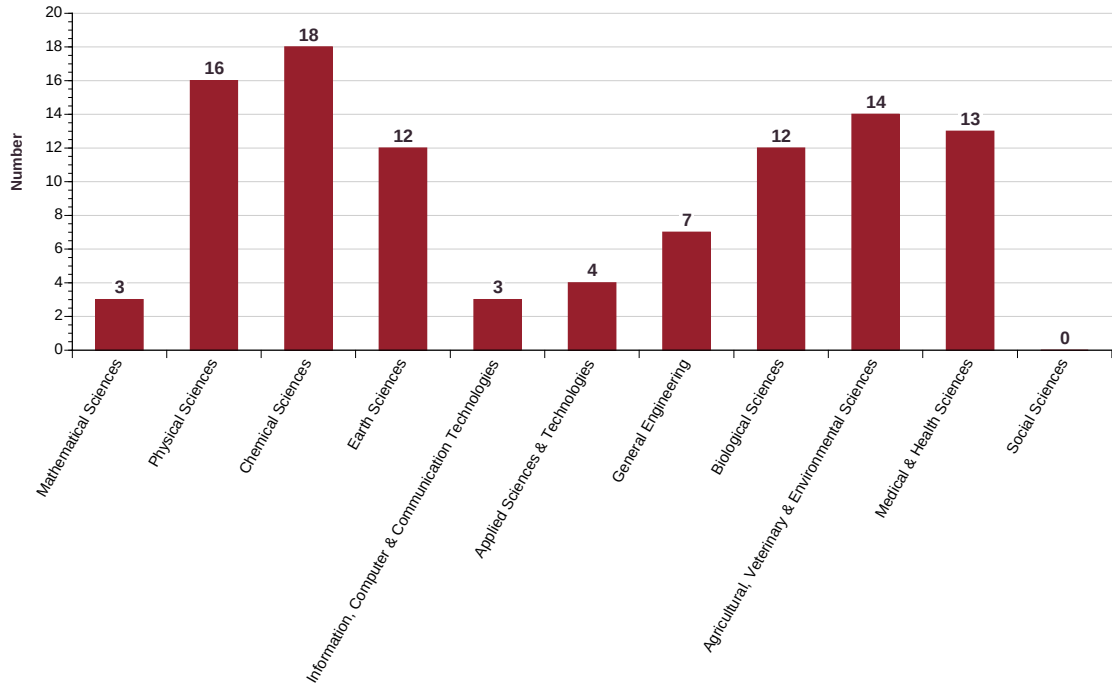


Source: The Allen Consulting Group
Note: **Other**: Greece, Netherlands, Taiwan, Mexico, Denmark, Italy, Sweden

All fields of research, apart from Social Sciences, are represented in ISTN collaborations. Chemical and Physical Sciences contained the highest number of international collaborations, with many individual activities associated with these fields of research being in new materials and nanotechnology (see Figure A20). Other fields of research where collaborations were common include Agricultural, Veterinary & Environmental, Medical & Health, Biological and Earth Sciences. In terms of expenditure, however, Agricultural, Veterinary and Environmental Sciences, accounted for the highest amount, with more than Physical and Chemical Sciences combined. This may be due to the number of sustainable development conferences and workshops that are included in expenditure in Agricultural, Veterinary and Environmental Sciences.

Figure A20

IAP-IST ISTN – ACTIVITY BY ASRC

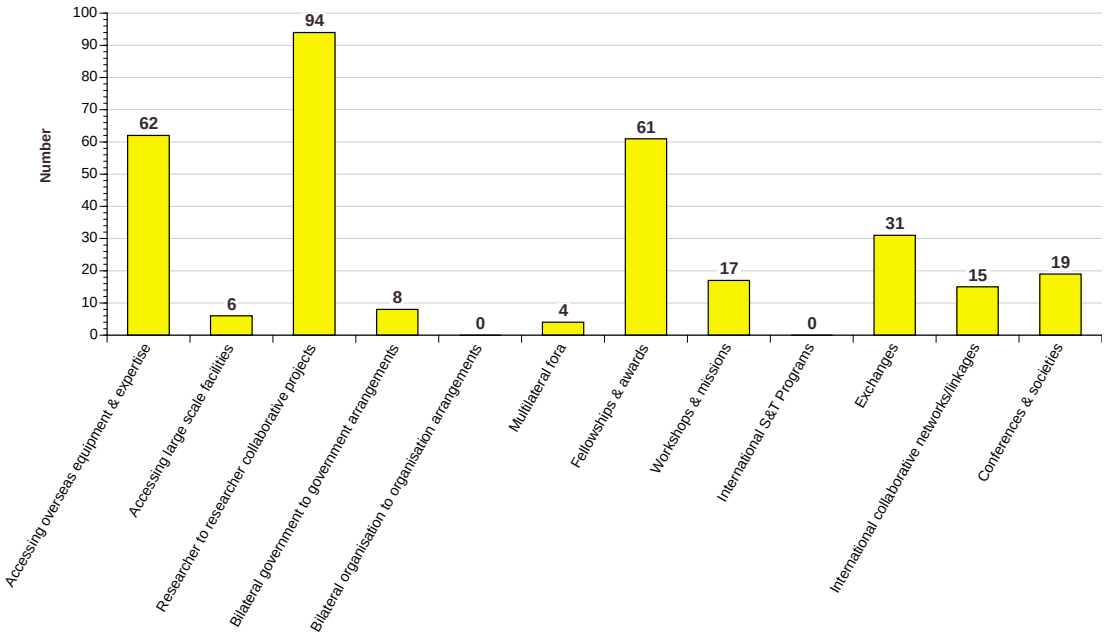


Source: The Allen Consulting Group

The purpose for these international collaborations was most often 'researcher to researcher collaborative projects', and for 'accessing overseas equipment and expertise' (see Figure A21), a finding that is indicative of the high number of international exchanges included in the AAS's international activities. The purpose of the AAS' activities is also reflected in the distribution of 'fellowships & awards' and 'exchanges' (where the AAS supports visits to Australia by international researchers) in Figure A21. Alternately, the ASTE's activities are represented by collaborations with purposes including, 'workshops & missions', 'bilateral organisation to organisation arrangements', 'international collaborative networks/linkages' and 'conferences & societies'.

Figure A21

IAP-IST ISTN – ACTIVITIES BY PURPOSE AND TYPE



Source: The Allen Consulting Group

The Australian Academy of Science

The Australian Academy of Science (AAS) received $714,500 to deliver activities for the ISTN Programme, in financial year 2001-2. Of the three international activities within the AAS, 1) International Exchanges, Fellowships and Awards, 2) Fellowships funded by the Japanese and Korean Governments, and 3) Bilateral Activities, only the first is of relevance to this study since these international activities utilise Commonwealth sourcesd funds.

These Exchanges, Fellowships and Awards support international collaboration by providing travel grants to Australian professional researchers for short-term scientific visits to Europe, North America and Asia, and long-term postdoctoral fellowships to Japan and Korea. They support a smaller number of visits to Australia by foreign scientists, which is for Australian-based international collaboration (twenty-nine in 2001-2) (see Table A5 for regional expenditures). A total of 91 international collaborations were reviewed, comprising fellowships, exchanges, and various fora, that were administered by the AAS and undertaken in 2001-2.

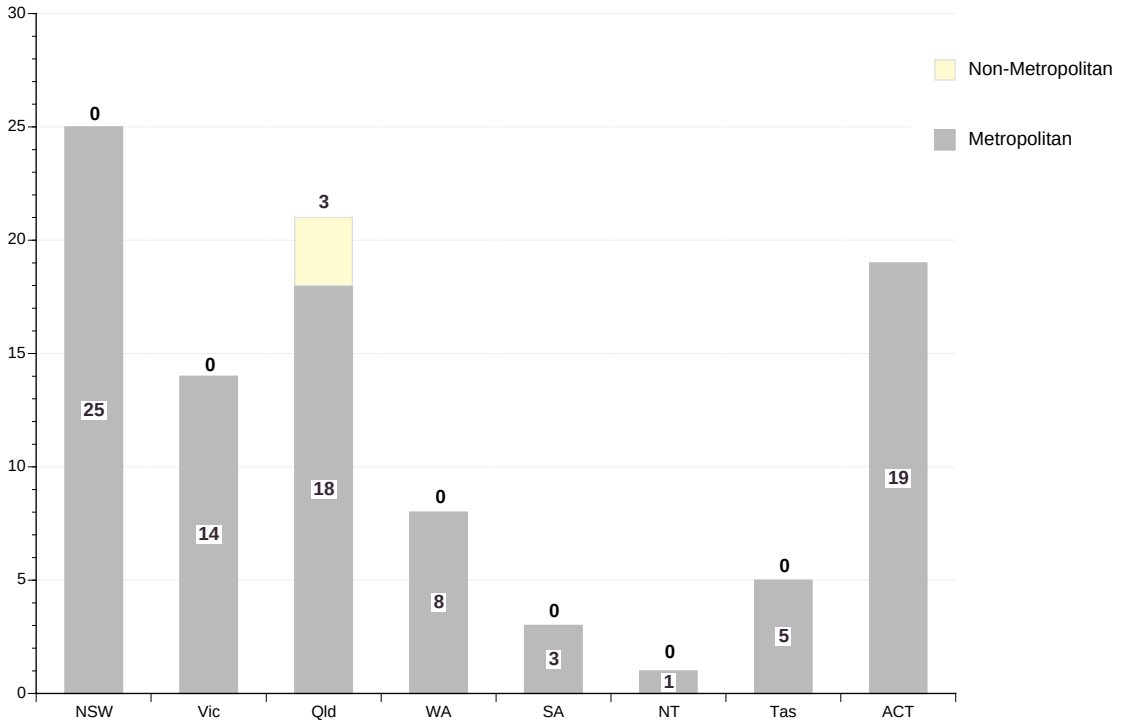
The most common locations for the AAS's international collaborations were the US, Japan and China, with expenditure on collaborations in China being approximately half that of the other two nations. The international collaborations encompassed a wide range of S&T fields but most commonly involved activities in the Chemical, Physical, Biological and Medical & Health Sciences, with Agricultural, Veterinary & Environmental and Earth Sciences also prominent.

The purpose of collaboration was most often researcher-to-researcher collaborative projects and accessing overseas equipment and expertise. In post-collaborative evaluations collected by the AAS the majority of participants stated that their visits had a strongly positive influence upon future international collaboration. In addition, while conferences were not often a purpose for these collaborations, the majority of participants presented research seminars (often more than once) to their international colleagues.

Scientists participating in the AAS' international exchanges mostly came from the metropolitan centres Sydney, Canberra, Brisbane and Melbourne respectively. The geographical distribution Australian scientists participating in the AAS' international exchanges, fellowships and awards are illustrated in Figure A22.

Figure A22

IAP-IST ISTN – RESEARCHERS BY GEOGRAPHIC LOCATION



Source: The Allen Consulting Group

Academy of Technological Science and Engineering

The ATSE received $285,500 from the ISTN in 2001-2. Its international activities support IAP-IST and ISTN objectives, with particular emphasis placed upon establishing and supporting long-term relationships with both 1) leading international bodies concerned with SET and 2) non-government members of the SET community in countries of economic import to Australia. International activities conducted by the ATSE as part of ISTN in 2001-2 included workshops in Australia, overseas workshops, overseas missions, delegations visiting Australia, bilateral activities and multilateral activities.

A total of 18 international activities organised by the ATSE in 2001-2 were reviewed, which involved 23 collaborations (13 with Asian nations and the remainder within Europe or North America). The purpose of these international activities was often 'bilateral government to government arrangements', 'workshops and missions' and 'international collaborative networks/linkages'. ATSE states that these activities work to uphold Australia's access to global S&T, and build productive strategic alliances among the developers and users of S&T in the public and private sectors.

Sir Mark Oliphant International Conference Series

Facilitating access to the frontiers of international S&T is a major focus of the IAP-IST and is addressed by the Sir Mark Oliphant International Frontiers of Science and Technology conference series. This scheme was launched in 2001, the centenary of Sir Mark Oliphant's birth, and provides financial support for international conferences in Australia that address S&T fields deemed to be strategically important, cutting edge and/or multidisciplinary.

These conferences cut across traditional S&T boundaries and provide forums for prominent Australian and international research providers, and users, to establish and enhance international collaborations. Two important objectives for this scheme include, the facilitation of strategic alliances among Australian researchers, international researchers and industry, in addition to the promotion of Australian S&T capabilities internationally.

This initiative replaced the International Conference Support Scheme (ICSS), a component of the Technology Diffusion Program, administered by Engineers Australia since May 1989. Engineers Australia continues its administrative role under the Oliphant conference scheme and the Academies (AAS & ATSE) organise and manage the conferences. Each conference receives funds of up to $100,000, with one or two conferences held per annum.

A1.3.2 Access to Major Research Facilities

This outsourced component of the IAP-IST assists researchers to access major research facilities in other countries. It is managed by ANSTO. Some of these facilities are multinational (eg the European Synchrotron Radiation Laboratory) while others are national facilities that can be accessed by researchers from Australia or by international teams of researchers including Australians. The facilities access include neutron sources, synchrotrons and telescopes.

Analysis of this component in Figures A23 and A24 shows that the major activities involve the US, multinational facilities and the UK, with the US accounting for 40 per cent of expenditure. Not surprisingly, research funded under this component is in the Physical, Chemical and Biological Sciences (see Figure A25).

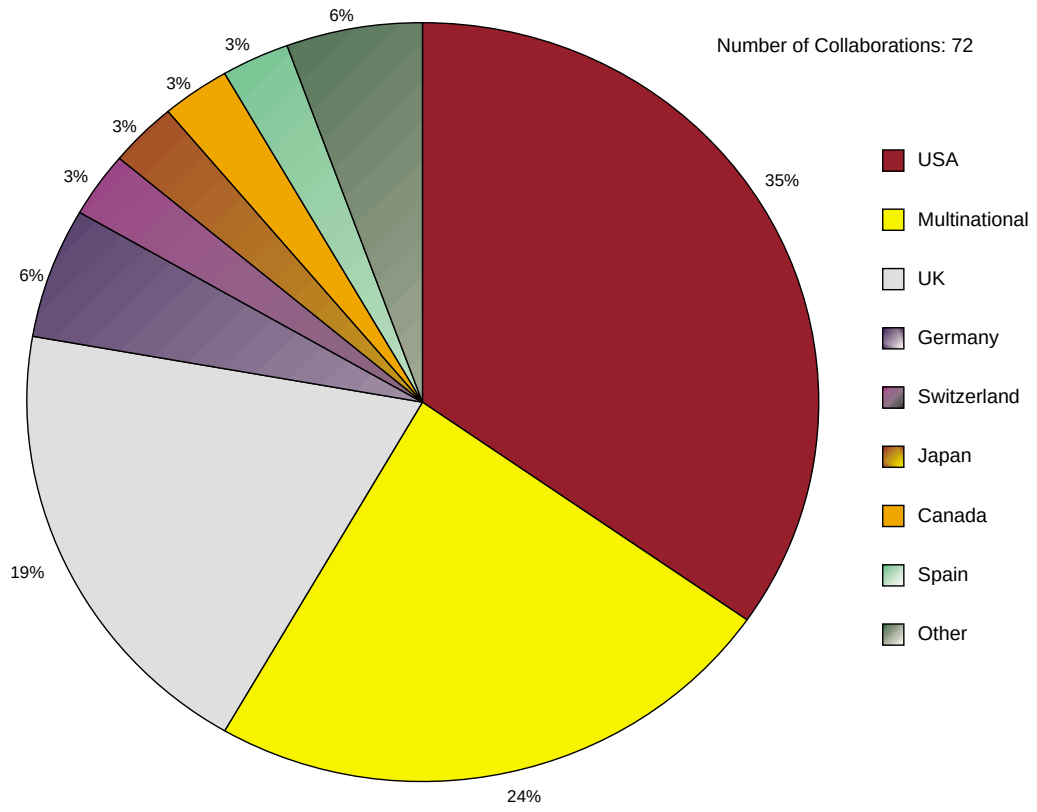
A1.3.3 Access to High Energy Physics Facilities

This outsourced component of IAP-IST assists researchers to access high-energy physics facilities at KEK in Japan and CERN in Switzerland. The Australian High Energy Physics Consortium administers this component at no cost to the Commonwealth. The former is classified as a Japanese national facility and the latter as a multinational facility.

Figures are not included for this component as there are only 7 activities amounting to $216,526 of Commonwealth expenditure on international collaboration in 2001-2 (expenditure in 2001-2 is more than the $100,000 of annual Commonwealth appropriation for this component). Furthermore, in all of the activities, the collaborating countries are either multinational or Japan, the field of research is Physical Sciences, and the 40 Australian researchers are located in metropolitan NSW and Victoria.

Figure A23

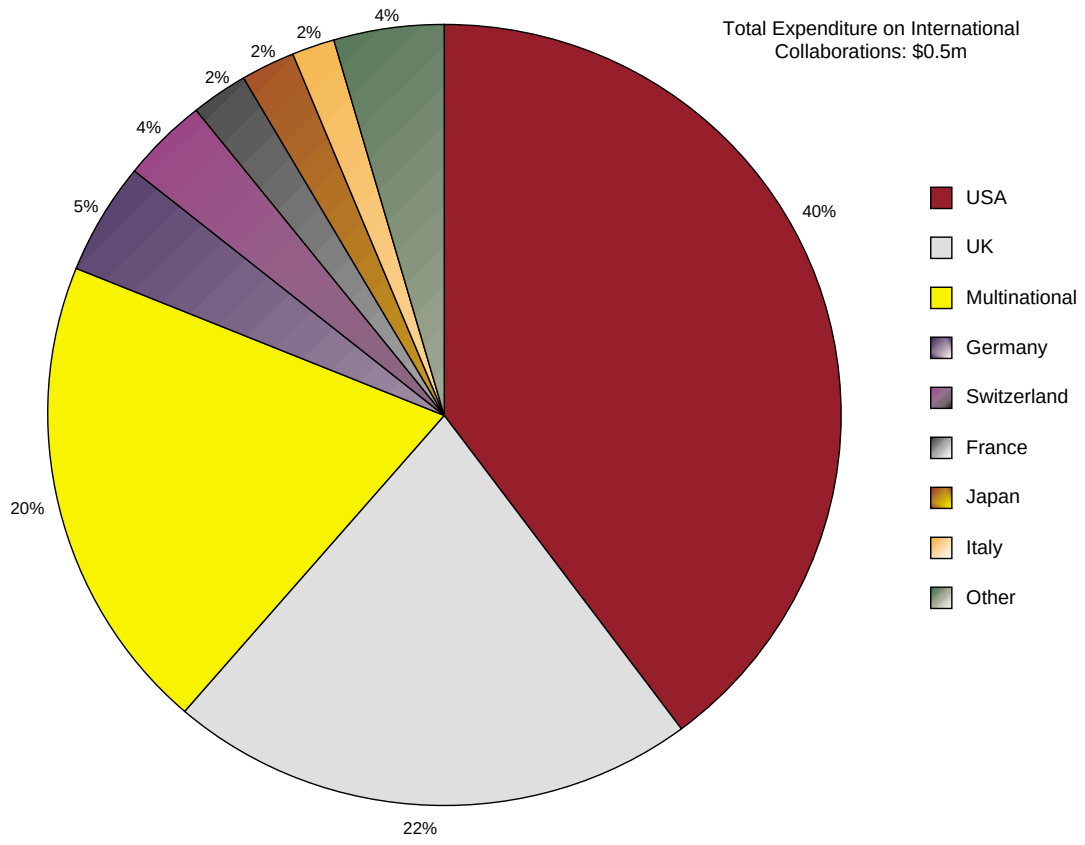
IAP-IST AMRF – COLLABORATION BY COUNTRY/ECONOMY



Source: The Allen Consulting Group
Note: **Other**: France, Italy, Korea, Taiwan

Figure A24

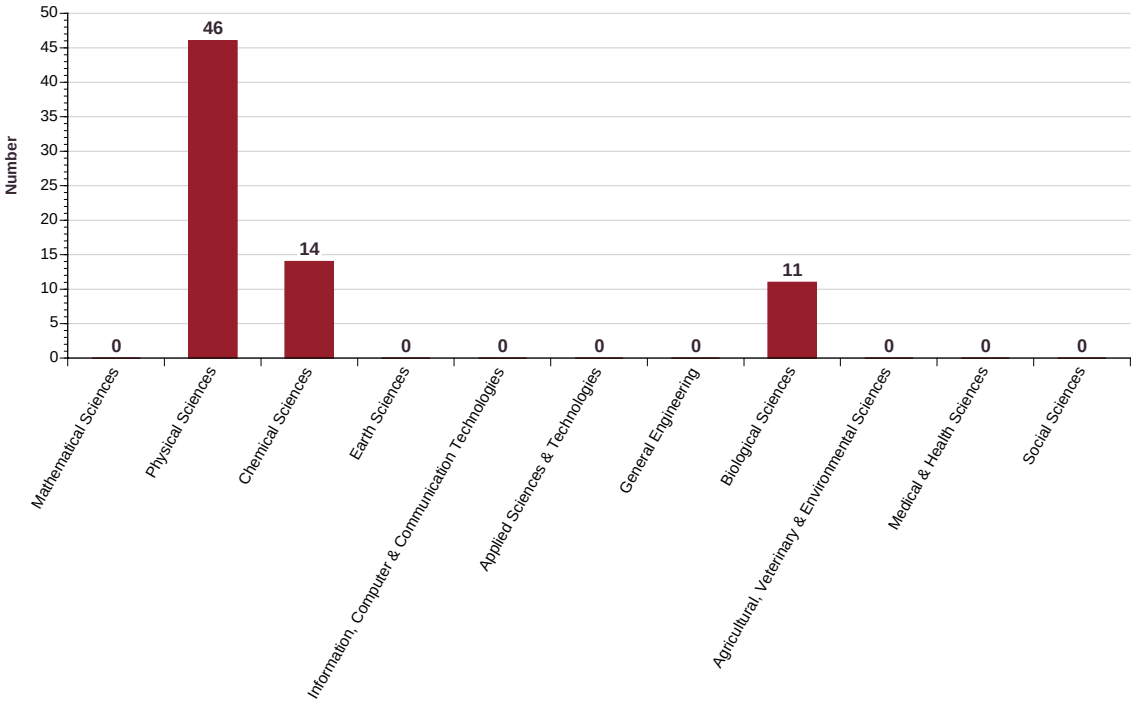
IAP-IST AMRF – EXPENDITURE BY COUNTRY/ECONOMY



Source: The Allen Consulting Group
Note: **Other**: Canada, Spain, Korea, Taiwan

Figure A25

AMRF – ACTIVITES BY FIELD OF RESEARCH



Source: The Allen Consulting Group

A2 The Major National Research Facilities (MNRF) Programme

The MNRF Programme facilitates access by Australian researchers to very large-scale national research facilities. Contributions to the capital costs of overseas major facilities are provided where this is considered to be of importance to domestic researchers to keep them at the leading edge of key scientific and technological developments but where no domestic facility exists. In addition the Programme funds a proportion of the capital and operating costs for existing and proposed large-scale facilities in Australia. In 2001, two MNRFs were supported that are specifically international in their focus, the Australian Synchrotron Research Programme and the Gemini SKA (Square Kilometre Array): Australia's Astronomy Future.

In 2001, fifteen facilities were selected to receive $155m over five years. The Programme Budget was $4.5m in 2001-2, but expanded to $25m in 2002-3.

Because these MNRFs were still in the process of getting established in 2001-2, most of them reported no international activity. Four MNRFs reported activities with the United Kingdom; Japan and China; and Germany; and multinational respectively. One MNRF reported a $2.3m project that would take place in subsequent years. Total international expenditure reported in 2001-2 was approximately $180,000.

It can be expected that, as these MNRFs get fully established, their international S&T activities will increase. For example, one MNRF that incurred no Commonwealth Government expenditure in 2001-2 reported that in 2003 it spent approximately $3.3m on international cooperation activities with the US, Japan and Taiwan, involving 73 Australian researchers.

A3 The Cooperative Research Centres (CRC) Programme

The CRC Programme goal is to maximise the social, economic and commercial benefits of research to Australia by enhancing cooperative linkages between researchers and research users in the public and private sectors. CRCs are normally established under formal contracts with the Commonwealth to operate for seven years mainly focusing on the natural sciences and engineering and their application. The 2001-2 Budget of $146.5m involved mainly domestic expenditures.

It is difficult to estimate the proportion of Commonwealth and other funding directed to international collaborative activities of CRCs. Analysis of CRC Annual Reports for 2001-2 provides no information on the levels of funding directed to international activity. These reports provide information on the number of international links, with only a few CRCs providing sufficient information for systematic analysis. These few are not representative of all CRCs and do not provide a basis for estimating the number of links, distribution by country and field of research.

The Management Data Questionnaire, which is completed annually by CRCs, requests information on numbers of international collaborations but not on the extent of investment in this activity.

While this report was being prepared a major review of the CRC Programme is in progress. As CRC's were being asked to make inputs into that review it was decided not to request international expenditure data from them. Given that the CRCs had not been asked to collect this data in the past, it is likely that they would have had some difficulty in providing it.

The only numerical data available is the number of international organisations with which 47 CRCs reported links in their responses to the 2002 *Management Data Questionnaire*. It is reported[57] that Question 7 in the *Management Data Questionnaire* deals with major international collaborative linkages established by CRCs. It excludes linkages that exist because of personal contacts or visits, unless these fall into the category of strategic alliances with companies or research organisations that could lead to substantial benefits to Australia. This is summarised in Table A6.

The data in Table A6 shows a wide range among CRCs in terms of the number of international collaborations per CRC. Some CRCs collaborate with a small number of overseas organisations, while at the opposite extreme, the Photonics CRC collaborates with 48 international organisations.

Due to the lack of data on international S&T expenditures for the CRCs, an estimate has been developed. This estimate was derived from figures for international S&T expenditures for the Photonics CRC (presented in a case study of this CRC, see Box A1). The Photonics CRC estimates that 15 per cent ($914,000) of its total expenditure, went to international S&T collaborations in 2001-2. Scaling up the proportion of international S&T collaboration for the Photonics CRC for all the CRCs in Table A6 results in an estimate that indicates that expenditure on international S&T for all CRCs was in the order of $12m.

[57] BioAccent Pty Ltd and Capital Hill Consulting, 2002, *Measuring CRC Outcomes: Terms of Reference for CRC Programme Evaluation and a New Approach to CRC Performance Measurement*, prepared for the Department of Education, Science and Training .

Tabla A6

COOPERATIVE RESEARCH CENTRES - NUMBERS OF COLLABORATING INTERNATIONAL ORGANISATIONS

Centre	*Number of International Partners*	*Centre*	*Number of International Partners*
AJ Parker	18	Landscape Evolution and Mineral Exploration	2
Renewable Energy	33	Legumes in Mediterranean Agriculture	35
Petroleum	4	Materials Welding & Joining	15
Photonics	48	Mining Technology and Equipment	3
Advanced Composite	9	Plant Breeding	46
Alloy and Solidification Technology	16	Low-Rank Coal	8
Antarctica	37	Polymers	2
Aquaculture	9	Wool	5
Mineral Exploration Technologies	11	Wheat	4
Pest Animals	26	Robust & Adaptive Systems	31
Black Coal	12	Satellite	13
Telecommunications	10	Southern Hemisphere Meteorology	6
Cardiac Technology	10	Savannas	5
Catchment Hydrology	8	Forestry	19
Cellular Growth Factors	1	Rice	6
Cochlear	9	Tourism	8
Marsupials	4	Cattle and Beef Quality	8
Diagnostic Technologies	4	Tissue Growth	13
Great Barrier Reef	31	Tropical Rainforest	5
Food	35	Viticulture	8
Freshwater Ecology	10	Waste Management	8
Polymers	5	Water Quality	13
Intelligent Manufacturing	18	GK Williams	11
International Food Manufacture	1	Total	643

Source: BioAccent Pty Ltd and Capital Hill Consulting, 2002, *Measuring CRC Outcomes: Terms of Reference for CRC Programme Evaluation and a New Approach to CRC Performance Measurement*, prepared for the Department of Education, Science and Training .

This estimate has a number of limitations. The Australian Photonics CRC' estimate is based on a case study of two of its nodes, scaled up by applying the proportions within the two nodes to the expenditure of the whole CRC. The number of links with international organisations is not the best possible measure because only some of these links will have active projects with associated funding.

The data on individual CRC collaborations in Table A6 is based on responses to a survey question. The rate of international activity will differ between CRCs according to the nature of the fields of research and industries involved.

Despite these limitations, the estimate of $12m expenditure on international links of CRCs is likely to be conservative. An experienced CRC manager, who was consulted in regard to this estimate, believes the estimated amount to be reasonable. The CRCs' contribution to international collaboration in S&T is highly significant.

The Commonwealth share of expenditures for CRCs is 30 per cent, and therefore, the estimate used for expenditures on international S&T collaborations for this study is $4m, or approximately one third of the total of $12m discussed above. The CRC estimate is included in the overview of the Commonwealth expenditures in Chapter 3.

Box A1

INTERNATIONAL S&T COLLABORATIONS OF THE AUSTRALIAN PHOTONICS COOPERATIVE RESEARCH CENTRE

The Australian Photonics CRC was established in 1992 with 29 participants including five universities, TAFE NSW, DSTO and 22 industry and business participants. The CRC undertakes R&D, education and training and commercial activities with a view to underpinning the growth of the photonics industry in Australia. Research and education groups are located in Sydney, Canberra, Melbourne and Adelaide.

Over 100 full time equivalent researchers are developing new technologies that will increase the capacity of optical fibre networks. In particular, the Centre is undertaking research on photonics integrated circuits, novel photonics components, telecommunications technologies, photonic information processing and advanced photonic manufacturing. The research program achieves a mix of activities progressing from basic research to commercially driven applied research and product development. This provides a research continuum in which new building blocks for photonics are conceived, developed and enhanced into new photonics networking architectures and applications.

The CRC spent an estimated $914,000 in 2001-2, predominantly on industrial research projects which have links with international organisations. The internationally linked activities also include strategic and applied research and education and training. Some of the internationally linked projects are focused on education, and nearly all of the commercial joint ventures have training components.

Korea

The Australian Photonics CRC has had a ten-year history of collaboration with Korea. Collaborations with commercial potential include

- Joint research collaboration on poled fibre with the Electronics and Telecommunications Research Institute (ETRI).
- Joint research and staff and student exchanges with the Information and Communications University.
- Joint collaboration and R&D with the Korea Photonics Technology Institute.
- A joint commercial venture with a CRC subsidiary, Redfern Polymer Optics, and Samsung Electronics.
- Involvement in the planning and operation of the annual Australia-Korea Photonics Summer School in Seoul.
- Collaboration with Daewoo Telecom and Seoul National University to provide novel optical network monitoring.
- An alliance with the Kwang-Ju Institute of Science and Technology to develop new fabrication processes.

Such collaborations have resulted in the CRC winning more than $1 million in research contracts from Korean companies. Bilateral photonics workshops organised and sponsored by the Australian and Korean government were a result of the CRC participating in the APEC Technomart in Korea in 1995.

China

The CRC is a partner in Jiangsu Fasten Photonics, which opened a manufacturing facility in Jiangyin in July 2001. The company is manufacturing several million kilometres of telecommunications grade optical fibre per year. The venture has created linkages between Australia and China at many levels, in research, education and commercial spheres. The CRC will hold a joint workshop in China in 2004 in partnership with Beijing University, Tsingua University and Jiangsu Fasten Photonics with a view to furthering the long term linkages.

Singapore

Singapore is a regional base for one of the CRC's early spin-off companies, VPI Photonics. Australian Photonics, through its investment company Redfern Photonics, received funding from Singapore's largest VC company and an investment arm of Singapore government, Temasek Holdings. The CRC has extensive links with Singapore's major leading photonics clusters, including the Photonics Association of Singapore.

Japan

The CRC has a long term collaboration with the Frontier Materials Laboratory at the Toyota Technological Institute, including frequent staff exchanges and workshops.

Europe and North America

A significant number of the CRC's PhD students gain post-doctoral experience in Europe and North America. The CRC has extensive links with research groups and companies in these regions. The CRC spin-off company VPI Photonics has operations in Germany and the USA. VPI Systems, which makes software to design, plan, configure and deploy communications equipment and network, has customer service and development teams in Australia, USA, Germany and Russia. Adaptif Photonics, a joint venture with Redfern Photonics, is based in Hamburg, Germany with products for dynamic optical networks.

Source: The Allen Consulting Group

A4 International Postgraduate Research Scholarships Scheme

The main objectives of the International Postgraduate Research Scholarships (IPRS) Scheme are to attract top quality international postgraduate students to areas of research strength in Australian higher education institutions and support Australia's research effort.

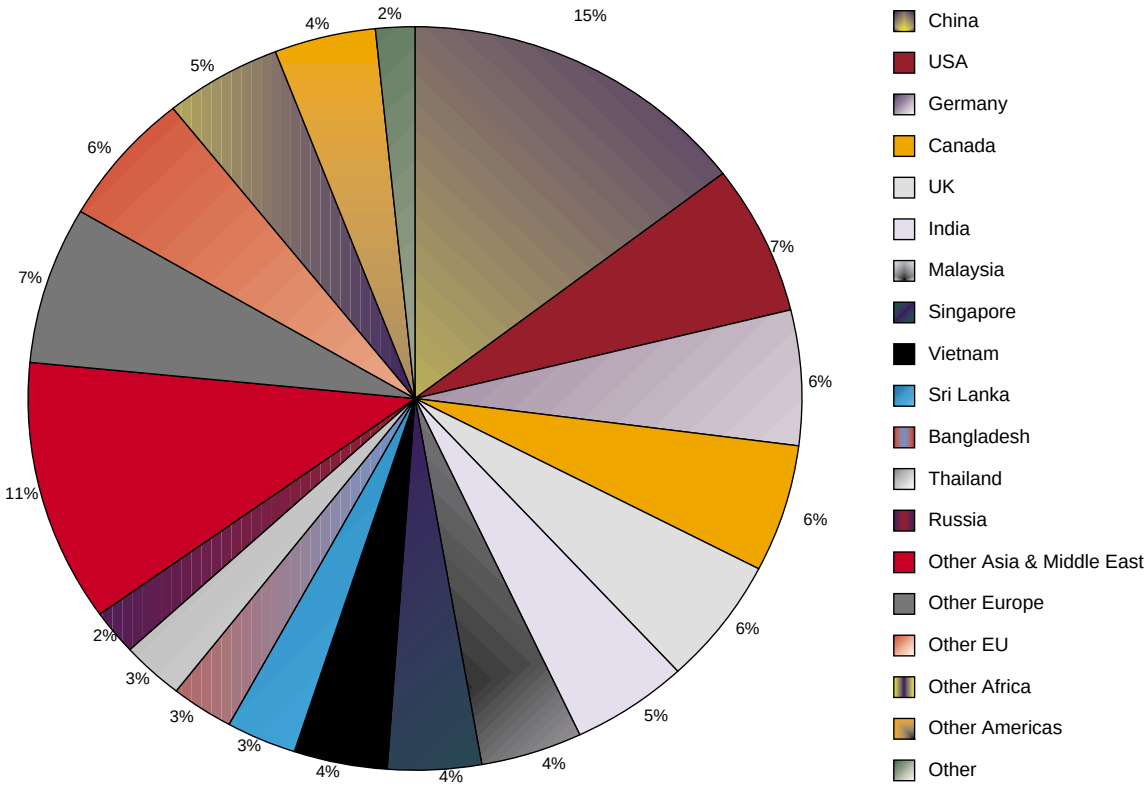
The IPRS Scheme enables international students to undertake a postgraduate research qualification in Australia and gain experience with leading Australian researchers. Scholarships are open to international students of all countries (except New Zealand) and are available for a period of two years for a Masters by research degree or three years for a Doctorate by research degree. The Scholarship covers tuition fees and health cover costs for Scholarship holders, and health cover costs for their dependents.

The allocation of scholarships to participating organisation is based on a formula that is reflective of their overall research performance. Each organisation is responsible for their own selection process for awarding scholarships and students lodge applications directly to a participating organisation.

Figure A26 gives the number of international research students by country/economy of origin. China is the dominant country of origin, as it is for IAP-IST competitive grant applications. This is notable given that the immigration conditions for scholars from some countries, including China, have been tightened in the last few years.

Figure A26

IPRS - SCHOLARSHIPS BY COUNTRY/ECONOMY OF ORIGIN



Source: The Allen Consulting Group and material provided by DEST

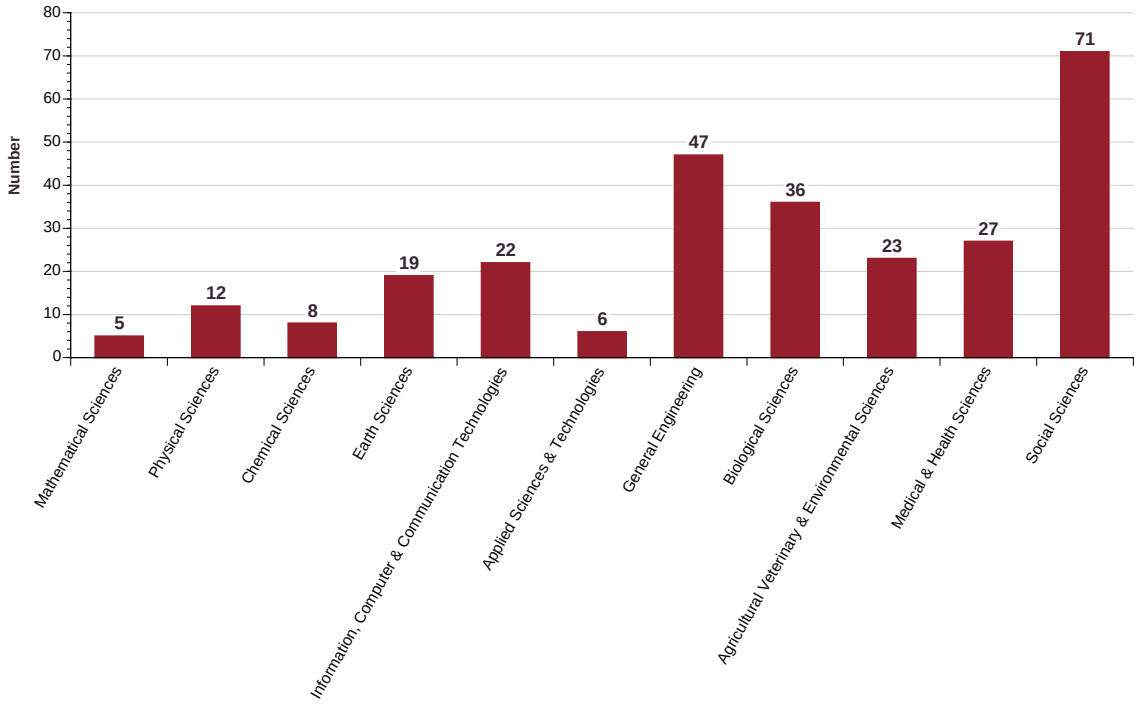
Notes:
1. **Other Asia & Middle East**: Indonesia, Taiwan, Israel, Iran, South Korea, Pakistan, Japan, Nepal, Hong Kong, Mongolia, Philippines, Fiji, PNG
2. **Other Europe**: Switzerland, Romania, Ukraine, Czech Republic, Poland, Croatia, Hungary, Macedonia, Norway, Slovenia, Turkey, Yugoslavia
3. **Other EU:** Austria, The Netherlands, Sweden, France, Belgium, Denmark, Portugal, Spain, Italy
4. **Other Africa**: Kenya, Nigeria, Zimbabwe, Malawi, South Africa, Tanzania, Zambia, Eritrea, Lesotho, Mauritius
5. **Other Americas**: Argentina, Colombia, Brazil, Bolivia, Chile, Mexico, Venezuela, Uruguay
6. **Other**: IPRS data provided without country names

The next highest group of countries, US, Germany, Canada and UK, are those with traditional S&T links to Australia. India, Malaysia and Singapore follow and are countries in the region where English is the dominant language of science.

In 2002 there were 307 awards of which 229 have been classified as S&T (including some social sciences). Assuming that total funding was approximately $15m, the share allocated to international S&T is approximately $11m. Figure A27 gives the number of international research students by ASRC broad field of research. IPRS awards are across all broad fields of research[58] with social sciences, engineering and biological sciences being dominant. Engineering and biological sciences also have a strong presence in funded IAP-IST competitive grants.

Figure A27

IPRS – ACTIVITIES BY FIELD OF RESEARCH



Source: The Allen Consulting Group based on data provided by DEST

Figure A28 gives the number of international research students by state and regional classification of the host Australian institution[59]. The proportion of regional representation follows the levels of research performed in regional universities.

A5 Australian Education International (AEI) Programmes

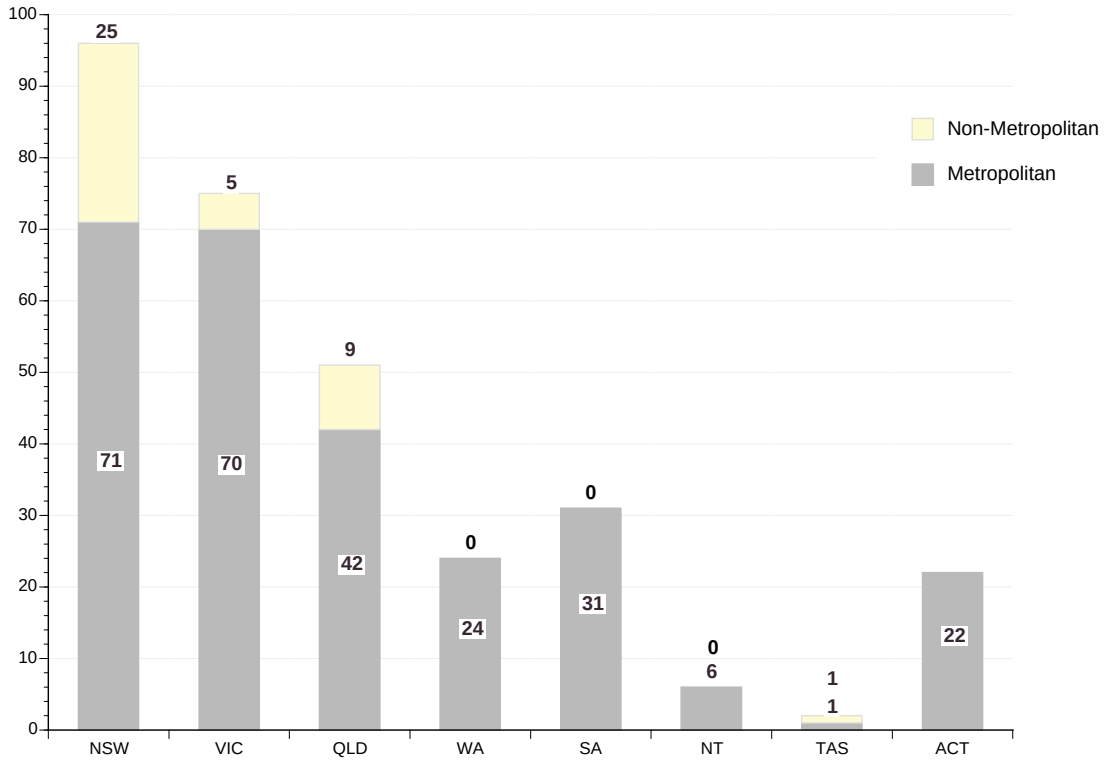
AEI promotes the capability of Australian education, science and training internationally. This international promotion of capabilities supports sustained improvement in Australia's international competitiveness and provides other social and economic advantages. The programme elements covered are the Australia-Asia and Australia-Europe Scholarships, providing $2.07m and $0.38m respectively in 2002. Social sciences, medical sciences and engineering are the most prominent fields of research in both, with physical sciences also significant in Australia-Asia Scholarships.

[58] Humanities has been excluded from this figure.

[59] The definition of a regional university is as provided in Section 4.4 of the higher education research White Paper *Knowledge and Innovation: a policy statement on research and research training*, December 1999.

Figure A28

IPRS - RESEARCHERS BY GEOGRAPHIC LOCATION



Source: The Allen Consulting Group based on data provided by DEST

The Australia-Asia Awards are prestigious awards for citizens of designated Asian countries to undertake high-level programs of study, training or research for up to 36 months in Australia. The Awards aim to strengthen Australia's relationships with its partners in Asia. They enable leading scholars and professionals from designated countries to undertake training, study or research programs, which will be of benefit not only to the individual but also the relationship between their home country and Australia. Korea and Thailand are the dominant countries, with a spread of awards across eight other countries in the region.

The level of funding for the award is intended to reflect the expectation that the awards will be offered to outstanding scholars and leaders from each eligible country. Each award is funded to a value of $50,000 per annum plus the cost of an airfare from the home country to Australia and return. The distribution of scholarships and funding for Australia-Asia Scholarships by state broadly follow the level of university research activity in each state and territory.

The Australia-Europe Scholarships aim to strengthen Australia's education and research relationships with countries in Europe. The scholarships enable scholars to undertake postgraduate study or research in target disciplines judged to be of benefit to both the individual and the relationship between Australia and the countries in which they are offered. Eligible countries are France, Germany, Italy, the Netherlands, Greece, Croatia, Slovenia, Finland, Hungary, Ireland and Switzerland.

The scholarships are tenable for a maximum of 12 months. Benefits include a stipend, a settling in allowance, a materials allowance, one international economy class return airfare by the most direct route between the designated country and Australia, related travel insurance, reasonable domestic travel costs, for conferences or other research activities in the approved program; visa and any related medical examination costs, enrolment, course and tuition fees for approved study (paid directly to the Host Institution); and basic health insurance costs while in Australia.

The distribution of scholarships and funding for Australia-Europe Scholarships by state broadly follow the level of university research activity in each state and territory, with the exception of Queensland. This is not surprising given the very small number of awards involved.

A6 Fulbright Awards

The Fulbright Exchange Programme was established in 1946 as an initiative of Senator J. William Fulbright of the US. Following the end of World War II he was committed to the ideal that mutual understanding through international education and exchange would 'find ways and means of living in peace'. The analysis is limited to Fulbright Awards funded by the Commonwealth for US scholars to undertake study and research in Australia. In 2002, this covered 18 Postgraduate Awards and 7 Senior Scholar Awards. Australian government expenditure was $704,000 of which half was for Social Sciences (Social Sciences dominate Fulbright Awards for US postgraduates and senior scholars to Australia).

Biological sciences are also significant for Postgraduate Awards. In terms of the geographic location of researchers, the Postgraduate Awards broadly follow the levels of research activity in the states. It is significant, however, that New South Wales regional institutions have a strong presence. The ACT dominates the Senior Scholar Awards, reflecting the strong interest in the Australian National University amongst US researchers.

A7 University Mobility in Asia and the Pacific Programme

The Australian University Mobility in Asia and the Pacific Programme (UMAP) provides funding to Australian higher education institutions to subsidise the cost of their establishing and monitoring, and of Australian students' participation in, UMAP student exchange programs with counterpart higher education institutions in the Asia Pacific Region. The Australian UMAP Programme was established in 1992 and has invited Australian higher education institutions to submit applications for funding under the Programme annually since 1993.

In the 2002 round, 79 projects from 26 Australian higher education institutions were supported with $1.4m. The recommended projects include 62 staff visits to counterpart institutions and participation of 348 Australian students (mainly undergraduate) from a wide range of disciplines.

The DEST area managing the Programme within the International Group has advised that approximately 5 per cent of programme funding ($70,000) was attributable to postgraduate research scholars. This Programme has little direct impact on international S&T collaborations.

A8 Australian Research Council

The Australian Research Council (ARC) became an independent body under the *Australian Research Council Act 2001* and plays a key role in the Australian Government's investment in the future prosperity and well being of the Australian community. The ARC's mission is to advance Australia's research excellence, to be globally competitive and deliver benefits to the community. Research in all fields of science, social science and the humanities is funded. For the purposes of this study, the international activities in the Humanities, Journalism and Law have not been included.

The next section provides a brief overview of ARC policy followed by a description of ARC international activities and an analysis of the expenditures that support international activities in science and technology fields, based on data for individual grant programs. All assumptions and methodologies for arriving at these estimates are provided in the detailed analysis for each grant program and at the end of this section.

A8.1 Overview of Policy

The ARC has three main forms of international activity — direct interaction with overseas agencies under international agreements; participation in international fora; and, support of international collaborations under the National Competitive Grants Program (NCGP). The NCGP provides funding under two main elements: Discovery and Linkage.

In its *Annual Report 2001-02* the ARC states explicitly that all ARC programs facilitate the development of collaborative research linkages with overseas researchers and research centres. In addition, the report states that the ARC works to advance Australian research through a range of international activities, in recognition of the increasingly global nature of research.

The ARC provides extensive analysis of its programs in its Annual Report including some analysis of international activities. Due to the large number of grants provided and the extensive data collection mechanisms in place at the ARC, they clearly are in the best position to analyse the international character of grants. However, the emphasis of the comprehensive data analysis in the 2001-2 Annual Report is not on characterising international collaborations *per se*. The task of characterising all grants in terms of their international collaborations would be akin to completely revising the ARC Annual Report. Clearly, ARC staff members were not in a position to do this within the time frame for this study. The solution involved meeting with the ARC staff and the Chief Executive Officer in order to agree on an acceptable methodology.

A8.2 International Agreements and Fora

The ARC has memoranda of understanding (MOUs) with 12 overseas research agencies in 11 countries as well as less formal agreements with six additional countries or bodies including the United States, the United Kingdom and Canada. The agreements provide an 'umbrella' under which international collaboration takes place.

The ARC also has research fellowship agreements with overseas research agencies in France, Germany, The Republic of Korea and the United Kingdom for the support of postdoctoral research. A further funding program for postdoctoral research in Japan is administered through the Australian Academy of Science.

The ARC participates in the OECD Global Science Forum, the R&D Leaders Forum of the Asia-Pacific Economic Cooperation body (APEC), the Forum for European-Australian Science and Technology Cooperation (FEAST) and the Asia–Pacific Nanotechnology Forum. The ARC does not report the associated numbers of S&T collaborations and the expenditures for these fora.

Expenditure on these international activities or the expenditure involved in maintaining an Australian presence in global fora has not been estimated. Although all funding organisations were asked for this information, without the accounting systems in place to record these expenditures when they are made, it is not possible for organisations to collect detailed information in this format *ex post*. In some cases there would also have been cross funding from other programs and this tracking would not be feasible with current systems in place.

A8.3 National Competitive Grants Program

A8.3.1 Overview of International Collaborations

Given the grant information provided by the ARC, 1,452 Discovery and Linkage grants were identified under the National Competitive Grants Program (NCGP) for which there were international collaborations in 2002. It is estimated that expenditures on an estimated 2,725 collaborations represent over 20 per cent of ARC expenditures on these programs. This estimate is based on the analysis provided below.

Table A7 and Figures A29 to A34 provide an overview of the estimated ARC expenditures on international collaborative efforts. All estimates are based on the available data and a common methodology for estimating the number of international collaborations and the expenditure on these collaborations. Details of assumptions and estimates are included for each program after this summary.

Table A7 provides an overview of expenditures by ARC program. Highlights include the following:

- On average, at least 21 per cent of the total of all Discovery and Linkage grant expenditures is for international collaborations.[60]
- Linkage-International expenditures are assumed to be 100 per cent international while Linkage–Projects are estimated to have the smallest proportion of international collaborations at 12 per cent.

[60] Total expenditures on international collaborations are under-estimated here due to data limitations. For example, international shares for Linkage–Infrastructure are estimated due to data limitations discussed below in the text. In addition, the analysis does not include characterisation of the $16.1m expenditure on Special Research Centres and the $461,890 Linkage-Learned Academies Special Projects, although there are likely to be international collaborations involved.

- The *curricula vitae* of the 2002 Federation Fellows illustrate the extensive international collaborative S&T networks maintained by 21 of the total of 25 Fellows. Since this is the case, 100 per cent of expenditures for these 21 awards is assumed to be expenditure on international collaborations. This expenditure on 21 Fellows ($6.1m) represents approximately 85 per cent of the total expenditure for the 25 Federation Fellowships ($7.2m).

- In terms of total ARC expenditure on international collaborations, twice the amount of the Discovery grant expenditure is estimated to be for international collaborations than for Linkage grants — 24 per cent versus 12 per cent (Table A7).

Table A7

AUSTRALIAN RESEARCH COUNCIL

Activity – 2002 Grant Year	*Commonwealth S&T Expenditure Analysed (1) ($ millions)*	*International S&T Expenditure Analysed ($ millions)*	*International Share of Program (per cent)*	*Program Share of All ARC International Expenditure (per cent)*
National Competitive Grants Program (NCGP)				
Discovery	***152.2***	***36.8***	***24***	***69***
Discovery – Projects	145.0	30.7	21	58
Federation Fellowships	7.2	6.1	85	11
Linkage	***107.1***	***16.6***	***15***	***31***
Linkage – Projects	77.1	9.0	12	17
Linkage - International	2.7	2.7	100	5
Linkage – Infrastructure	27.2	4.8	18	9
Special Research Initiatives	0.1	0.1	100	nil
International Agreements & Fora	N/A	N/A	N/A	N/A
Total	***259.3***	***53.4***	***21***	***100***

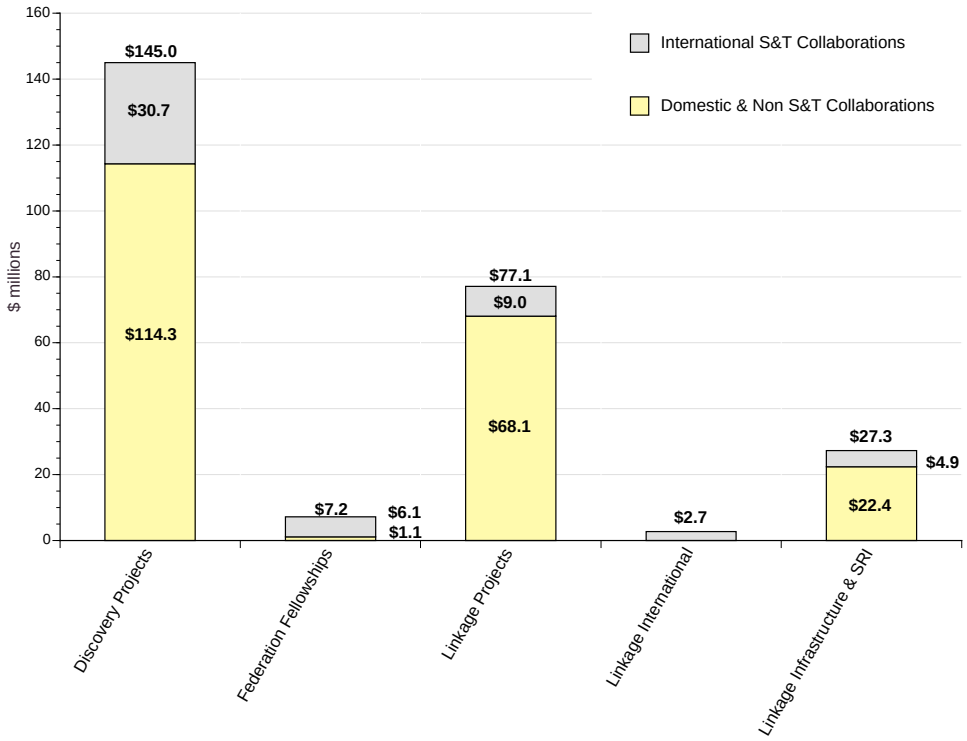
Source: The Allen Consulting Group
Note: These totals are based on *Australian Research Council Annual Report 2001-02* amounts, data provided by the ARC as well as ARC Website information.

In terms of total expenditure on international collaborations, Discovery grants dominate with 69 per cent of total expenditure on international collaborations of $53.4m. The remaining 31 per cent of international expenditures is through Linkage grants. However, the dominance of the Discovery program in international collaborations is mainly due to the greater amount spent on all Discovery grants. The Linkage program is approximately half the size, in terms of total expenditure, of the Discovery Program ($77.1m versus $145.0m) in the 2002 grant year.

Figure A29 illustrates the relative sizes of programs and the associated international shares. Linkage-International is 100 per cent international but program expenditures are small compared to the other programs. The international expenditures for all other programs overwhelm expenditures on the Linkage–International program. Federation Fellowships are small in absolute size but, as noted above, the activities and research programs of 21 of the 25 Fellows are largely international in nature. In contrast, Discovery–Projects and Linkage–Projects are estimated to be largely domestic.

Figure A29

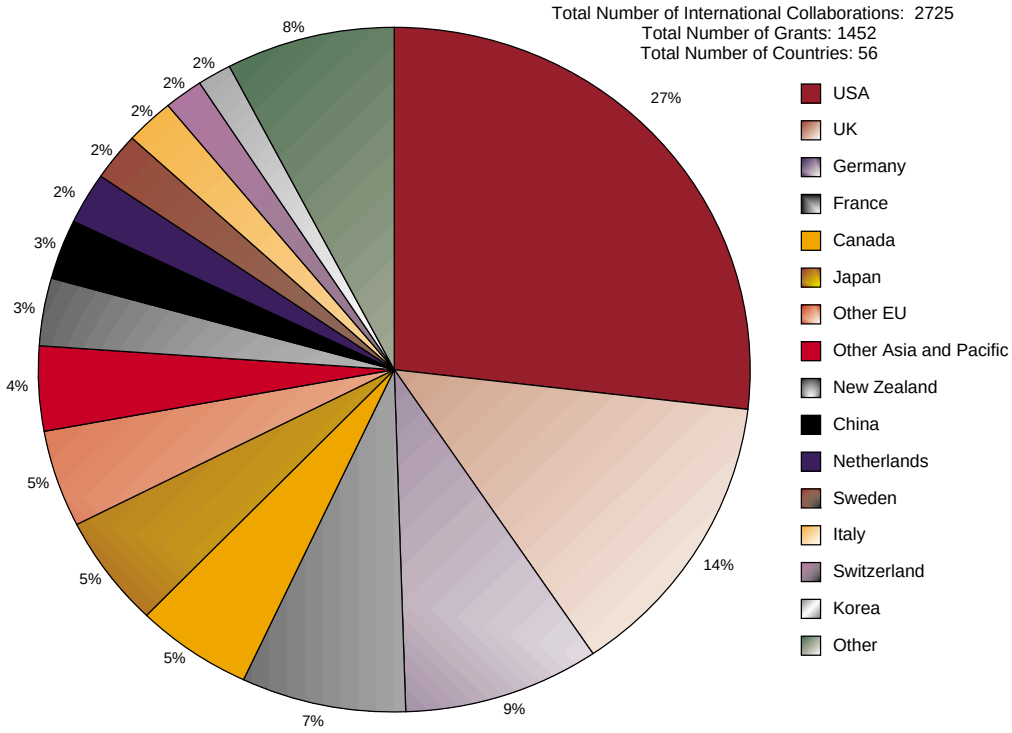
ARC GRANTS – INTERNATIONAL SHARES



Source: The Allen Consulting Group

Figure A30

ARC – INTERNATIONAL S&T COLLABORATIONS BY COUNTRY/ECONOMY



Source: The Allen Consulting Group

Notes:
1. **Other EU**: Denmark, Spain, Belgium, Austria, Finland, Portugal, Greece
2. **Other Asia and Pacific**: Hong Kong, Singapore, Taiwan, Philippines, New Caledonia, PNG, Indonesia, Cambodia, Malaysia, Thailand, East Timor
3. **Other**: Israel, South Africa, Russia. Norway, Brazil, Poland, India, Chile, Iran, Turkey, Multinational, Mexico, Argentina, Costa Rica, Czech Republic, Estonia, Georgia, Madagascar, Nigeria, Oman, Pakistan, Sri Lanka, Ukraine, Uzbekistan, Panama

A8.3.2 International Collaborations

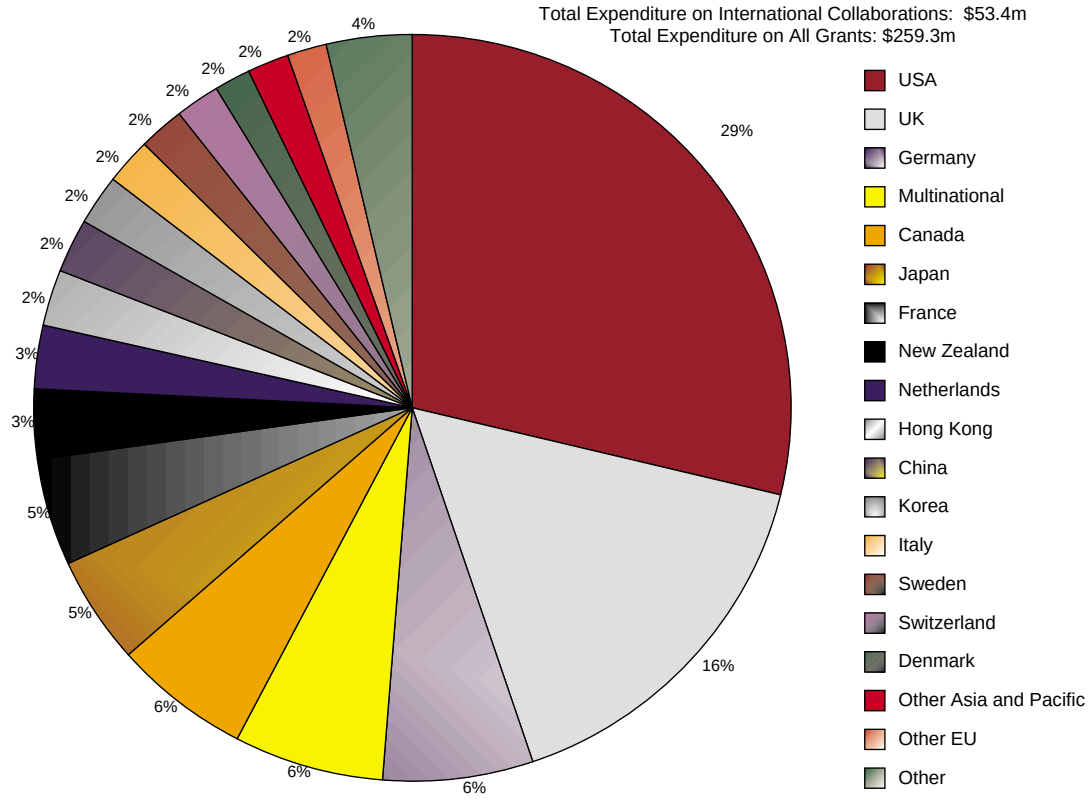
Figure A30 illustrates the estimated distribution of all international collaborations supported by ARC grants. An estimated 2,725 international collaborations with researchers in 56 countries were supported in 2002 under 1,452 grants. The US, UK and Germany represent half of all collaborations, France, Canada and Japan rank next in terms of collaborations. The Netherlands, Sweden and Italy are the main EU partners but they each represent only two per cent of collaborations with New Zealand and China each representing more at three per cent. These small shares are in sharp contrast to the 27 per cent of collaborations undertaken with the US.

A8.3.3 Expenditures

Figure A31 illustrates the distribution of the $53.4m expenditure on international collaborations. The rankings are similar to those for the number of international collaborations, with the exception of the relative importance of expenditures on multinational collaborations. Examples include the four large International-Infrastructure projects such as the International Gemini Partnership and a number of the Federation Fellowships.

Figure A31

ARC – EXPENDITURE BY COUNTRY/ECONOMY



Source: The Allen Consulting Group

Notes:
1. **Other Asia and Pacific:** Taiwan, Singapore, Philippines, Indonesia, East Timor, PNG, New Caledonia, Cambodia, Thailand, Malaysia
2. **Other EU**: Austria, Belgium, Spain, Finland, Portugal
3. **Other:** Norway, Poland, South Africa, Russia, India, Israel, Brazil, Panama, Uzbekistan, Costa Rica, Oman, Chile, Georgia, Sri Lanka, Madagascar, Turkey, Argentina, Mexico, Iran, Greece, Ukraine, Estonia, Pakistan, Nigeria, Czech Republic

A8.3.4 Fields of Research

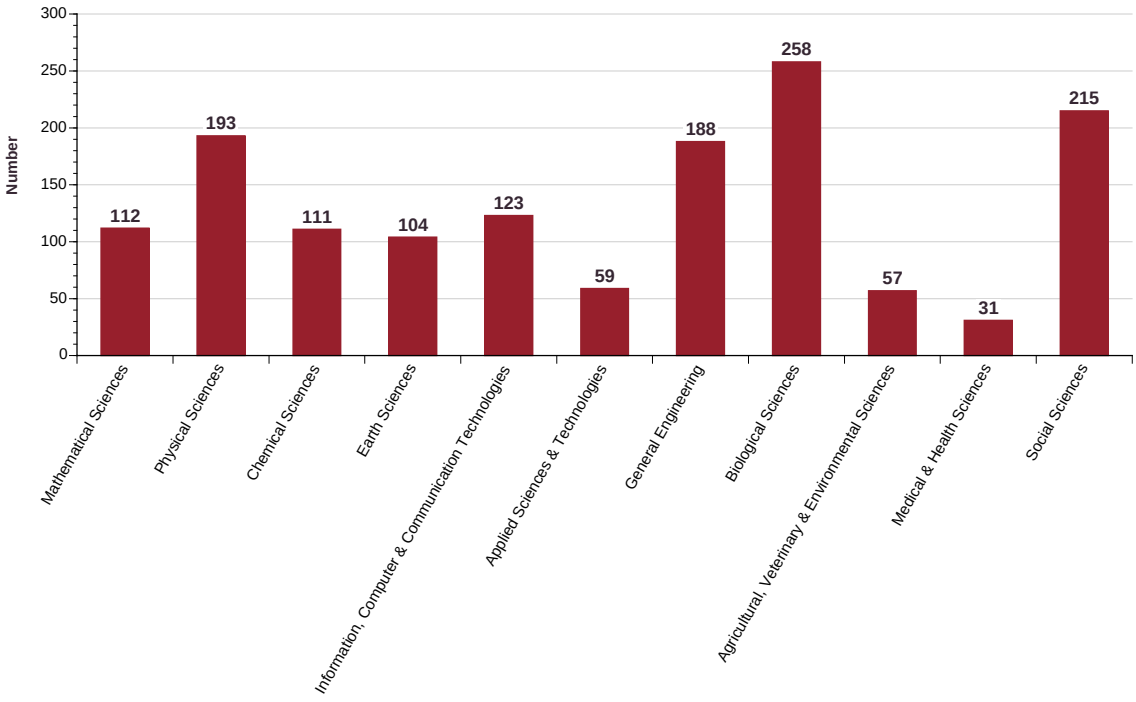
Fields of Research are illustrated in Figure A32 for the 1,452 ARC grants estimated to involve international collaborations. The emphasis on Biological Sciences, Social Sciences, Physical Sciences and the combination of Engineering and Applied Sciences and Technologies reflects the general distribution of all ARC grants. For those fields with relatively less funding, there tend to be other Commonwealth funding sources. For example, the NHMRC funds most Medical and Health Science research and Agriculture is funded through ACIAR and the RDCs. However, a direct comparison with all ARC grants is not possible because Humanities and Law are excluded here from the estimate of international collaborations.

Since the ARC codes grants at the more disaggregated level of ASRC according to Research Fields, in some cases it was necessary to re-group the ARC fields to match the broader ASRC codes used for this study. This re-coding is not ideal but it was necessary to simplify the analysis in order to provide an overview across the Commonwealth organisations analysed in this study. If a standard classification were used by all funding organisations, it would have been possible to provide a common picture without making some assumptions about how to re-assign codes.

It should be noted that each grant is counted once here so that a $5,000 Fellowship is counted with an equal weight to support of $1.6m for the International Gemini Partnership.

Figure A32

ARC – ACTIVITIES BY FIELD OF RESEARCH



Source: The Allen Consulting Group

A8.3.5 Activities by Purpose and Type of Research

Collaborations are characterised in Figure A33 by Purpose and Type of research. All Discovery–Projects and Linkage–Projects are included as a single 'researcher-to-researcher' collaboration for each grant since further grant details were unavailable to us. Fellowships include Linkage–International Fellowships granted in 2002 and Federation Fellowships.

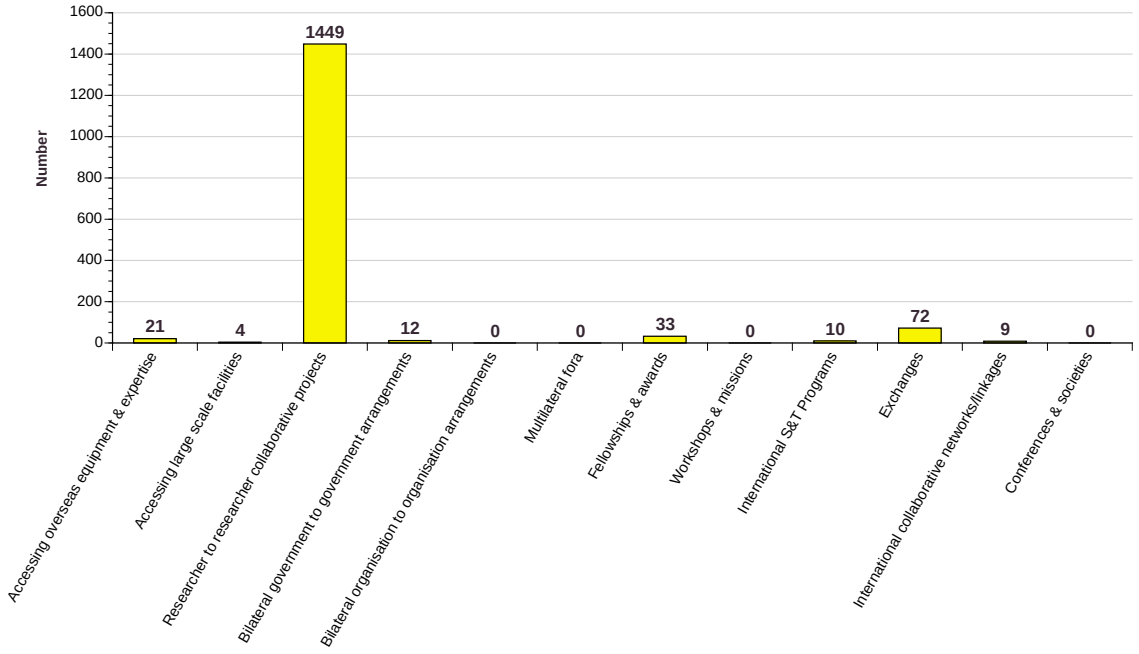
There is insufficient information to include the other ARC Fellowships here. Hence, the information in Figure A33 should be interpreted to represent the minimum number of international collaborations of each type supported by ARC grants.

In addition, as noted for Fields of Research in Figure A32, Figure A33 gives equal weight to all purposes regardless of the value of the collaboration, the expenditure on the collaboration and regardless of the number or quality of the overseas collaboration that is being forged.

Furthermore, the benefits to Australia are not indicated by a simple count of activities. These qualifications are relevant whenever simple counts are used as an indicator of activity and this simple indicator should be interpreted with care with its limitations in mind. Weighting each collaboration by its value to Australia is not feasible at this time or through a mapping exercise of this type.

Figure A33

ARC - ACTIVITIES BY PURPOSE AND TYPE



Source: The Allen Consulting Group

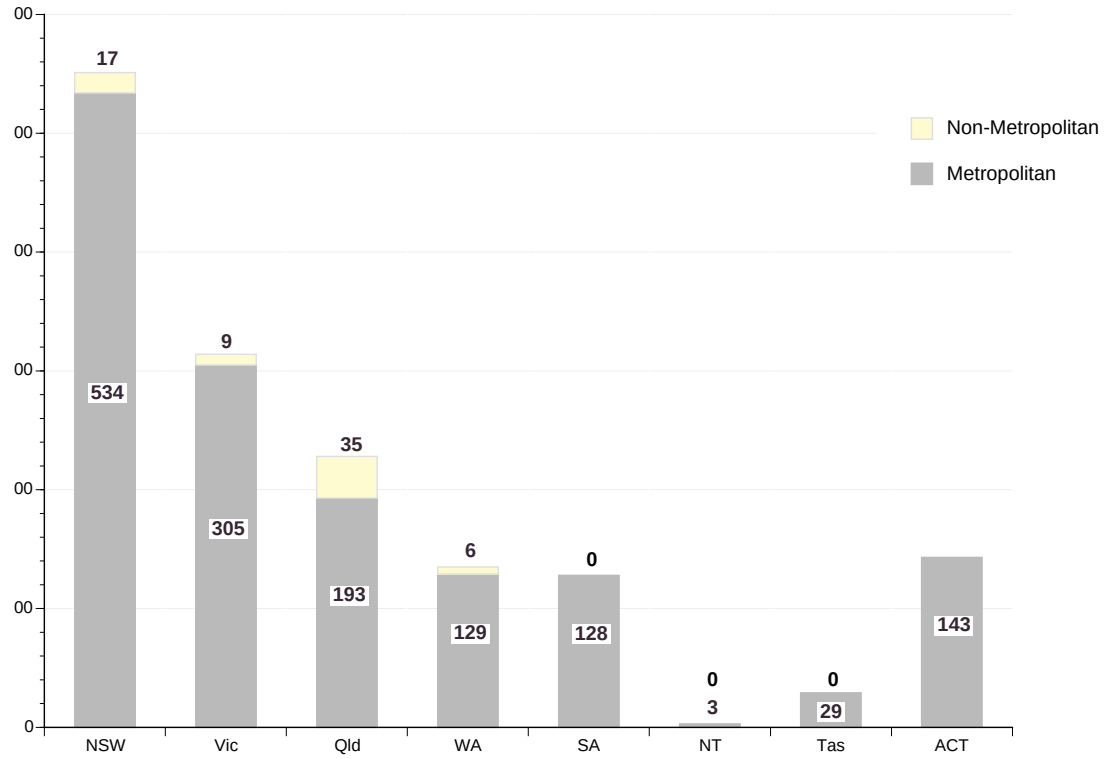
A8.3.6 Researchers by Geographic Location in Australia

Figure A34 illustrates the estimated distribution of researchers based in Australia who were involved in international collaborations supported by ARC grants. The ranking across States and Territories is similar to all ARC grants reported in the Annual Report. Due to data limitations, these findings cannot be compared rigorously to the total for all ARC grants. Detailed grant information is required to exclude Humanities, Law and the other non S&T grants from the *Annual Report* summaries and this is not available. Also, there is limited information concerning the Metropolitan/Non-Metropolitan split for grants.

In addition, these are minimum counts based on the grant recipient organisation location. The necessary grant details to fully characterise the location of all researchers involved on a grant are not available, however, these data could be interpreted to represent the number of research *teams* by location. Some exceptions were for Linkage–International grants where the ARC Website provided more detail on collaborating researchers on a grant-by-grant basis.

Figure A34

ARC – RESEARCHERS BY GEOGRAPHIC LOCATION



Source: The Allen Consulting Group

A8.4 NCGP – Program Analysis

As noted in the summary, the NCGP provides funding under two main elements: Discovery and Linkage. With one exception, the NCGP programs are not specifically intended to provide support for international collaboration, however, many of the successful grants have an international component involved. The Linkage-International Program, which is a sub-program of the Linkage program, is designed to support international collaborations exclusively.

Analysis of all grants is based on a detailed analysis of new 2002 grants, which were approved in 2001 for payment in 2002. New grants in 2002 were isolated in order to fully characterise one year of data according to international activity. The analysis is focussed on 2002 grants because it would have been an unmanageable task, in the time available, to analyse all grants active in 2002. Further, 2002 grant information is more readily available than information for other years.

The shares for new grants in 2002 were used to scale up for all grants active in 2002. Analysis of 2002 new grants provides a good picture of total grants since new grants represent a large share of total grants. For example, when compared to total grant expenditure, new Discovery grants in 2002 represent approximately one-third of the total value. The value of new and on-going Discovery grants funded in 2002 is $145.0m while the value of new grants is $57.1m. New Linkage Project grants total $25.9m while the total for new and on-going is $77.0m. New Linkage-International grants total $1.5m compared to total funding in 2002 of $2.7m. On average, new grants represent approximately 40 per cent of total grant funding for these programs in 2002. A more detailed explanation of the data and the methodology for scaling up from 2002 grants to on-going grants is included at the ARC appendix section.

A8.4.1 Discovery Grants

The Discovery program is not specifically intended to encourage beneficial international collaborations. The ARC states that the key objective of Discovery grants is to:

- develop and maintain a broad foundation of high-quality, world-class research across a wide range of disciplines.

The stated desired outcome is to advance knowledge leading to new discoveries and innovations and not to specifically encourage international collaborations to do this. However, as indicated by the analysis given below, Discovery grants provide significant support to international collaborations.

Discovery comprises three sub-programs, two of which are characterised by support for international collaborations.

- *Discovery–Projects* — provides research grants and fellowships for both small and large projects and clusters of projects. Fellowships include support for Australian Postdoctoral Fellowships (APDF), Australian Research Fellowships (ARF), Queen Elizabeth II Fellowships and Australian Professorial Fellowships (APF).
- *Federation Fellowships* — introduced in 2002 as part of the Backing Australia's Ability Commonwealth action plan, the fellowships are aimed at attracting and retaining leading researchers whose research is demonstrated to be of national interest.
  - Federation Fellows receive $230,000 per year plus on costs for a total of $289,703 per year and hosting institutions provide matching funding.
  - Funding is for five years and 25 Fellowships were awarded in 2002 with a total of 125 potentially to be awarded over five years.

A8.4.2 Discovery – Project Grants Analysis

In 2002 there were 2,194 new and ongoing Discovery–Project grants with fund of $145.0m. There were 786 new grants funded at $57.1m and 1,408 on-going grants funded at $87.9m. The success rate for applications was 25.4 per cent. The ARC reports that there were 161 Early Career Researchers funded out of 653 applications (a 24.6 per cent success rate).

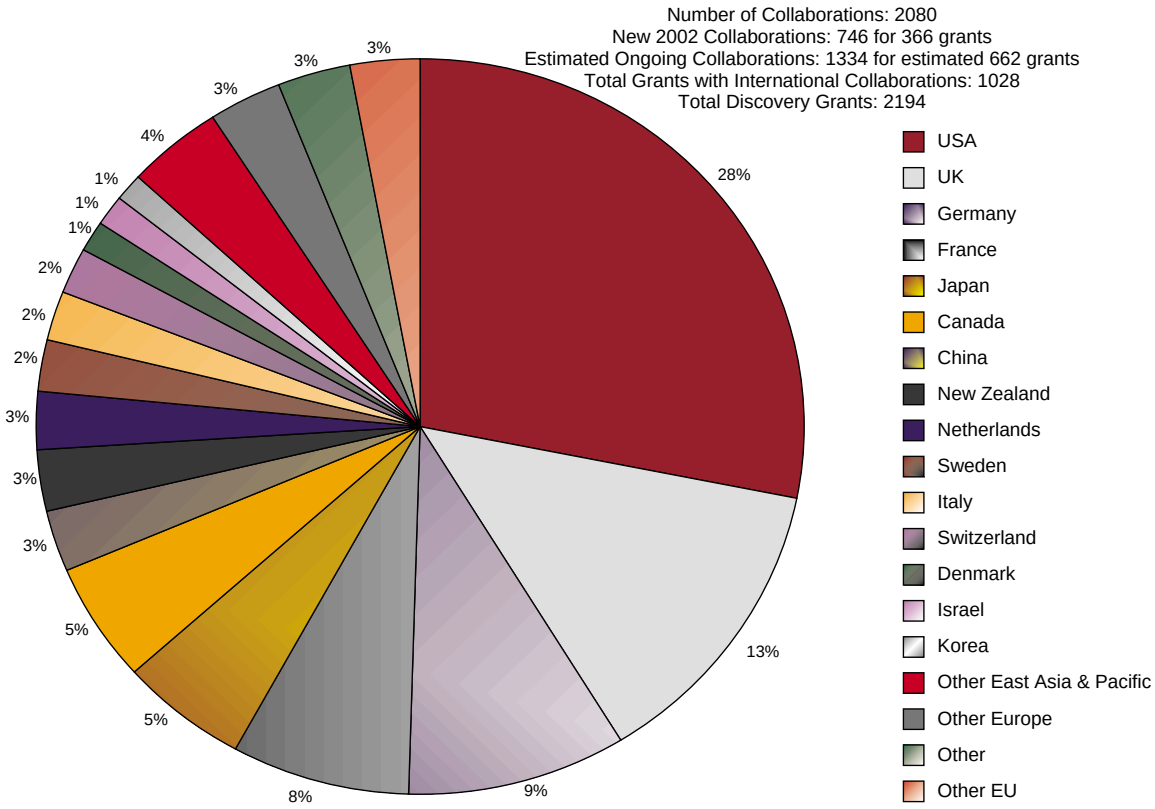
The grant data provided by the ARC indicate that approximately one half of all Discovery grants involved international collaborations, leading to 2,080 international collaborations with 56 different countries undertaken in 2002 for all Discovery grants.

The estimate of 2,080 collaborations is based on 123 grants where there was an overseas Partner Investigator (PI) and 243 grants where there were overseas investigators. These 366 grants represent almost one half of all new Discovery grants in 2002. Applying this share to ongoing grants implies a total number of grants with international collaborations of 1028. Analysis of individual grant data indicates that there were 746 collaborations associated with the 366 new grants in 2002. This implies that on average, there were two collaborations for each grant for a total of 2,080 collaborations estimated to be associated with the 1028 grants with international collaborations.

Figures A35 to A38 illustrate the characteristics of the estimated international collaborations funded by Discovery grants. Since Discovery–Project grants are estimated to represent 75 per cent of the number of all international collaborations and almost 60 per cent of the total of expenditure on international collaborations funded by ARC grants analysed above in Figures A29 to A34, the illustrations for Discovery grants alone reflect those for total grants. Hence the US, UK, Germany, France, Japan, China and Canada dominate as collaborative partners.

Figure A35

ARC DISCOVERY – INTERNATIONAL S&T COLLABORATIONS BY COUNTRY/ECONOMY



Source: The Allen Consulting Group

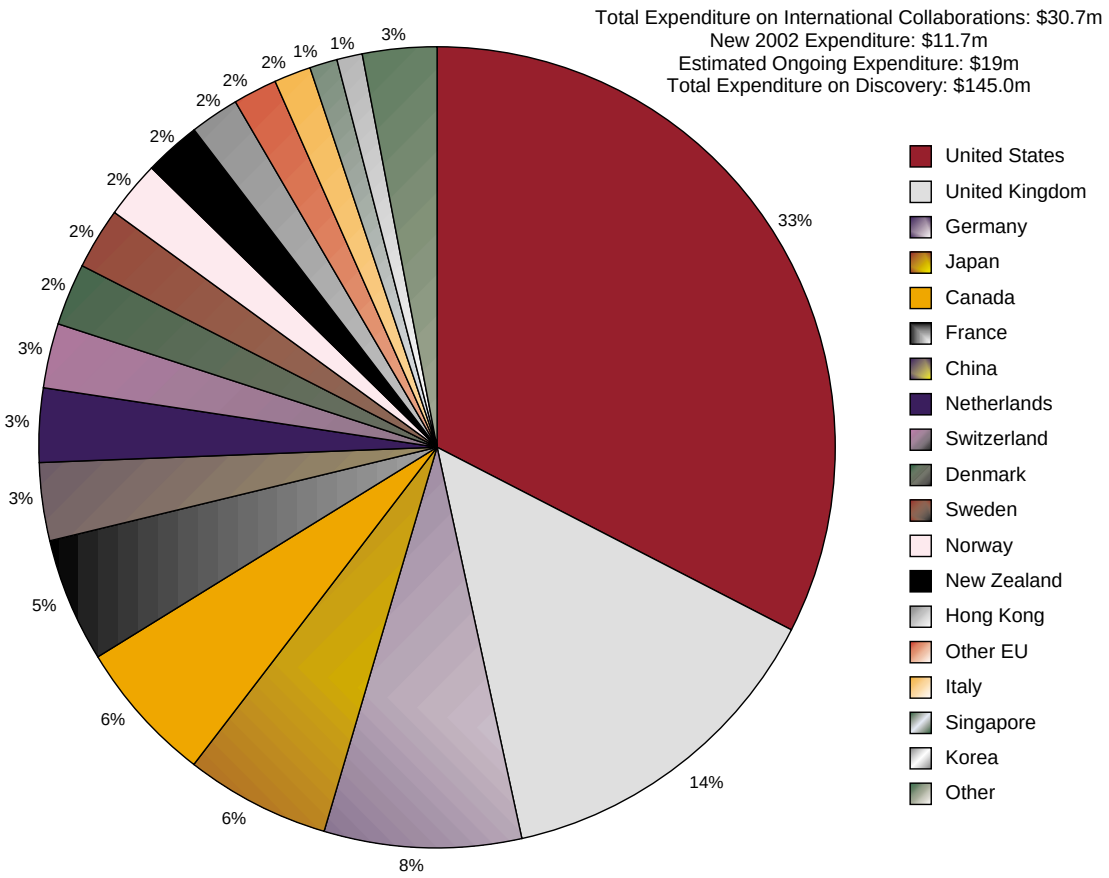
Notes:
1. **Other East Asia and Pacific**: Singapore, Taiwan, Hong Kong, New Caledonia, PNG, Philippines, Cambodia, Indonesia, Malaysia, Thailand
2. **Other Europe:** Norway, Russia, Poland, Turkey, Czech Republic, Estonia, Georgia, Greece, Ukraine, Uzbekistan
3. **Other:** Brazil, India, South Africa, Chile, Iran, Madagascar, Nigeria, Oman, Pakistan, Portugal, Sri Lanka, Argentina, Costa Rica
4. **Other EU**: Belgium, Spain, Austria, Finland

Fields of Research are characterised for the 1028 Discovery Grants with international collaborations involved in Figure A37. Since Discovery grants dominate the total of all international activities for the ARC, the summary figure above (Figure A32) reflects a similar pattern with Biological, Physical and Social Sciences dominating.

There is no detailed information available on Purpose and Type of research funded. Therefore, it is assumed that, at a minimum, for all 1028 grants where 2080 international collaborations have been identified, these can be characterised as 'researcher-to-researcher' collaborations. This is reflected in the summary for the total for ARC in Figure A33. Since Discovery grants dominate the 1028 grants involving international collaborations, their Geographic Location of Researchers dominate the ARC total as well. Since grant applications identify the location of the grant recipient institution rather than the researcher, the former is characterised in Figure A38. It is not possible to compare fully to ARC annual reports since Humanities and Law are excluded for this study.

Figure A36

ARC DISCOVERY – EXPENDITURE BY COUNTRY/ECONOMY

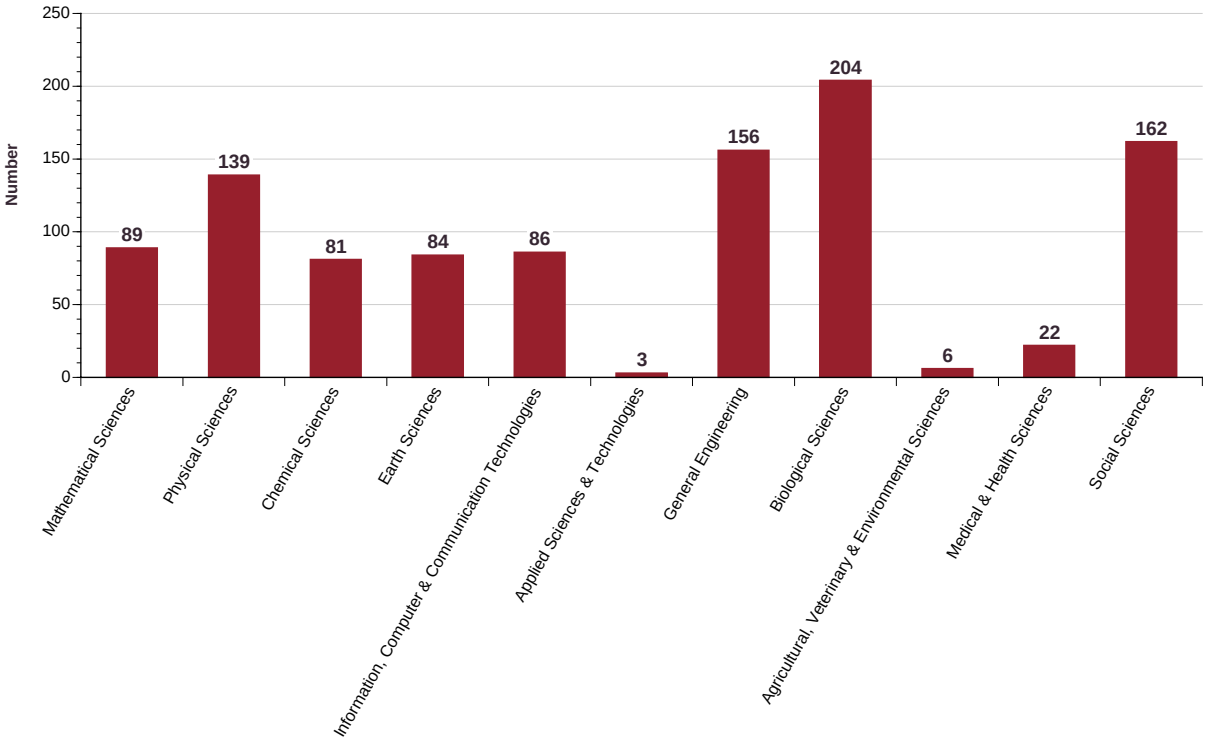


Source: The Allen Consulting Group

Notes:
1. **Other EU**: Austria, Belgium, Spain, Finland, Greece, Portugal
2. **Other**: Poland, Taiwan, Israel, Philippines, Brazil, India, Russia, South Africa, Papua New Guinea, Uzbekistan, New Caledonia, Costa Rica, Oman, Chile, Georgia, Sri Lanka, Madagascar, Turkey, Argentina, Iran, Ukraine, Estonia, Pakistan, Cambodia, Nigeria, Thailand, Czech Republic, Indonesia, Malaysia

Figure A37

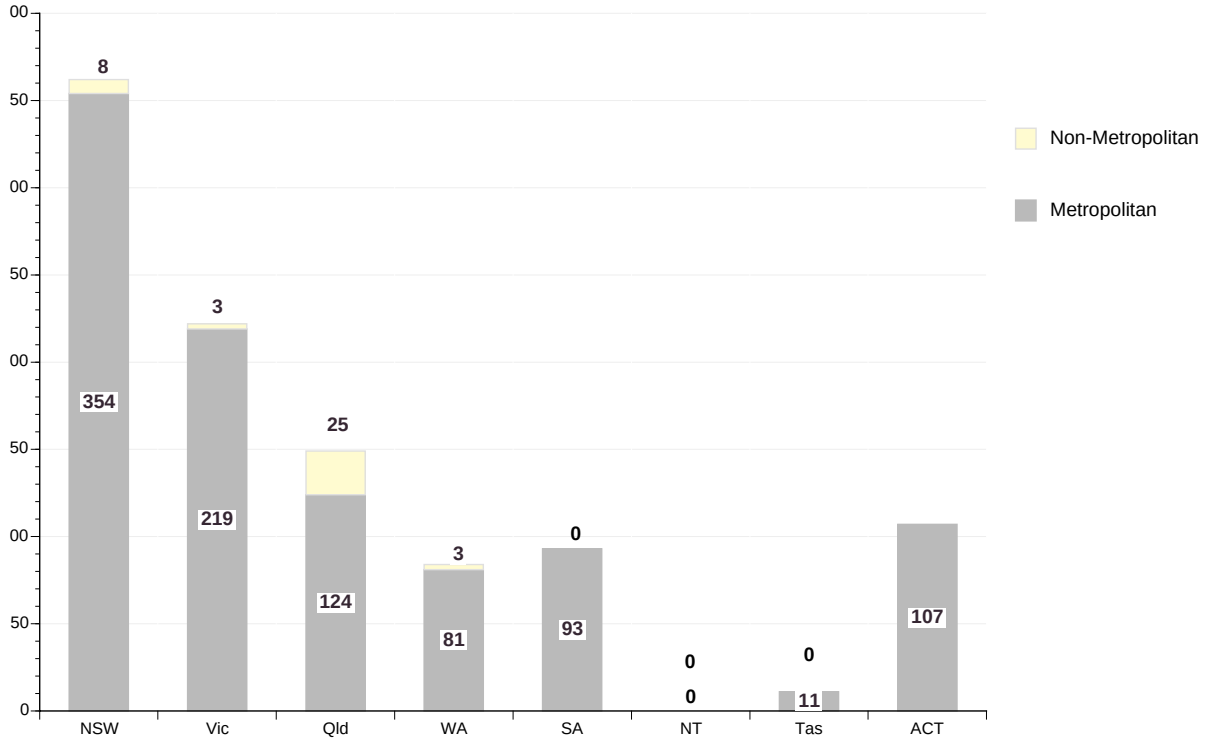
ARC DISCOVERY – ACTIVITIES BY FIELD OF RESEARCH



Source: The Allen Consulting Group

Figure A38

ARC DISCOVERY – RESEARCHERS BY GEOGRAPHIC LOCATION



Source: The Allen Consulting Group

A8.4.3 Discovery–Federation Fellowships Analysis

Based on the information provided on each Federation Fellow, it is estimated that 21 of the 25 total of Federation Fellows in 2002 undertook significant international collaborations in the S&T fields. A total of 65 incidences of international collaboration involving 21 countries were identified.

The average Federation Fellowship grant size, including salary and on costs, was approximately $290,000 in 2002 for a total estimated expenditure of $6.1m in 2002 for the 21 grants with international collaborations. It is assumed here that because of the international nature of the research projects undertaken by the Fellows, 100 per cent of the expenditure for Fellowships for the 21 of the total of 25 can be characterised as the Commonwealth expenditure on international collaborations. Figure A40 illustrates the distribution of the $6.1m estimate by country.

Seven Australians based overseas in S&T fields returned to Australia on these Fellowships, which are five years in duration. In addition, one foreign national will locate in Australia and take up a Fellowship.

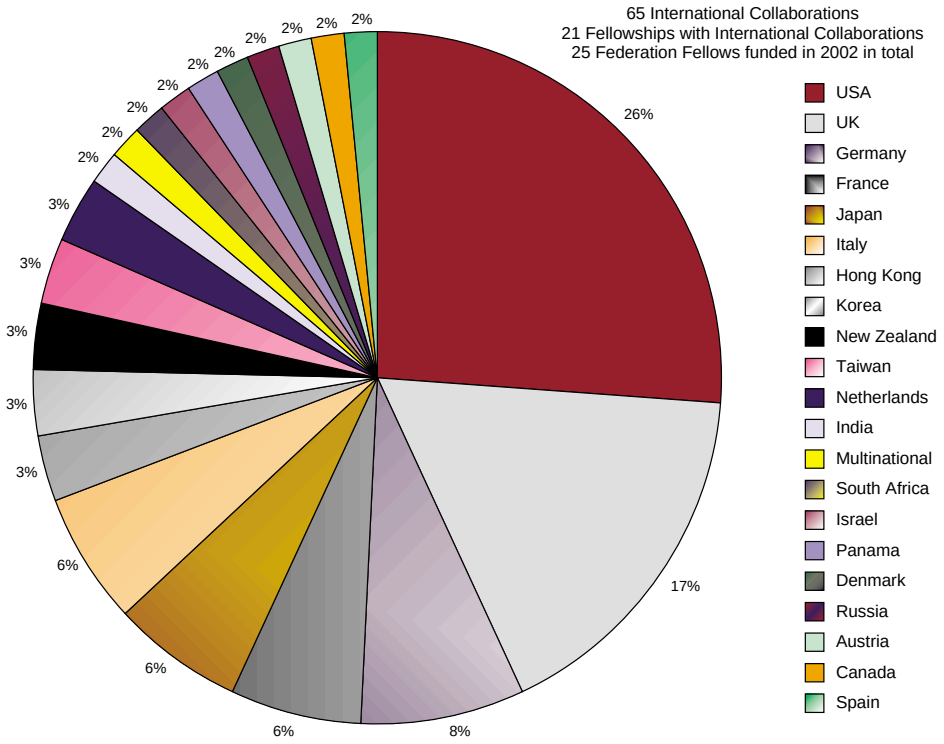
Figures A39 to A42 illustrate the characteristics of Federation Fellowships in 2002. The collaborating countries reflect the pattern for all ARC grants with the US, UK, Germany, France and Japan representing more than half of all collaborations. Fields of research are concentrated in Physical, Biological and Applied Sciences and Technologies. Given the limited information for coding, there may be some overlap between General Engineering and Applied Sciences and Technologies.

Data on location of researchers in Figure A42 reflects the location of the recipient organisation and not necessarily the location of all domestic research collaborators. The distribution reflects the shares for ARC grants overall with a relatively greater share in the ACT. Figure A42 reflects the fact that Western Australia, South

Australia, the Northern Territory and Tasmania were not represented in the 2002 round for Federation Fellowships.

Figure A39

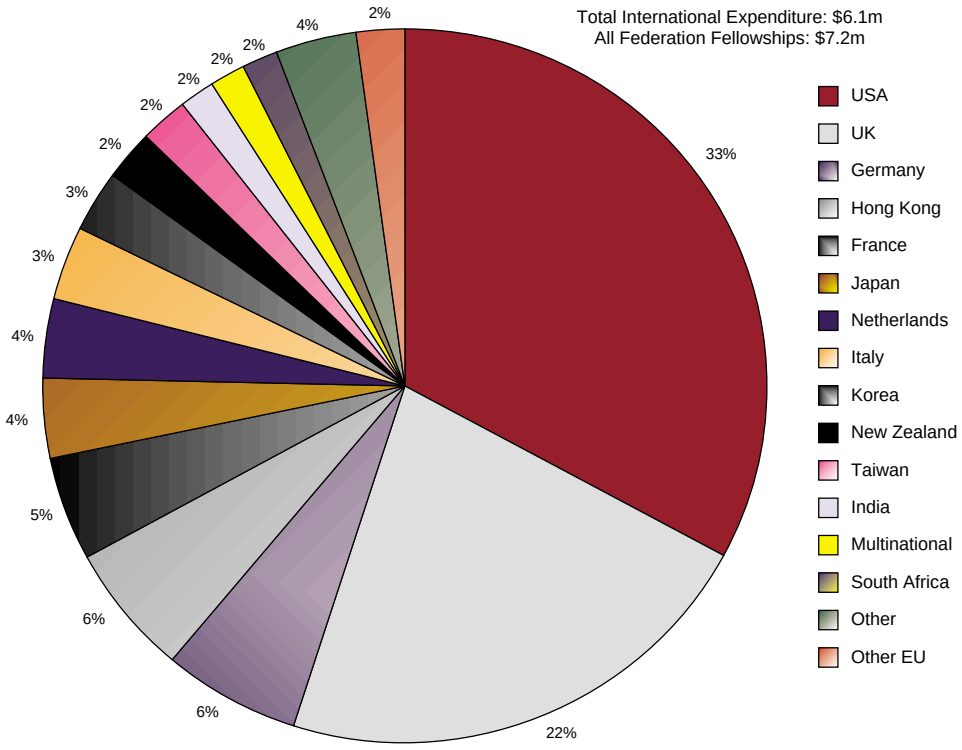
ARC FEDERATION FELLOWSHIPS – INTERNATIONAL S&T COLLABORATIONS BY COUNTRY



Source: The Allen Consulting Group
Note: 2002 Federation Fellowships

Figure A40

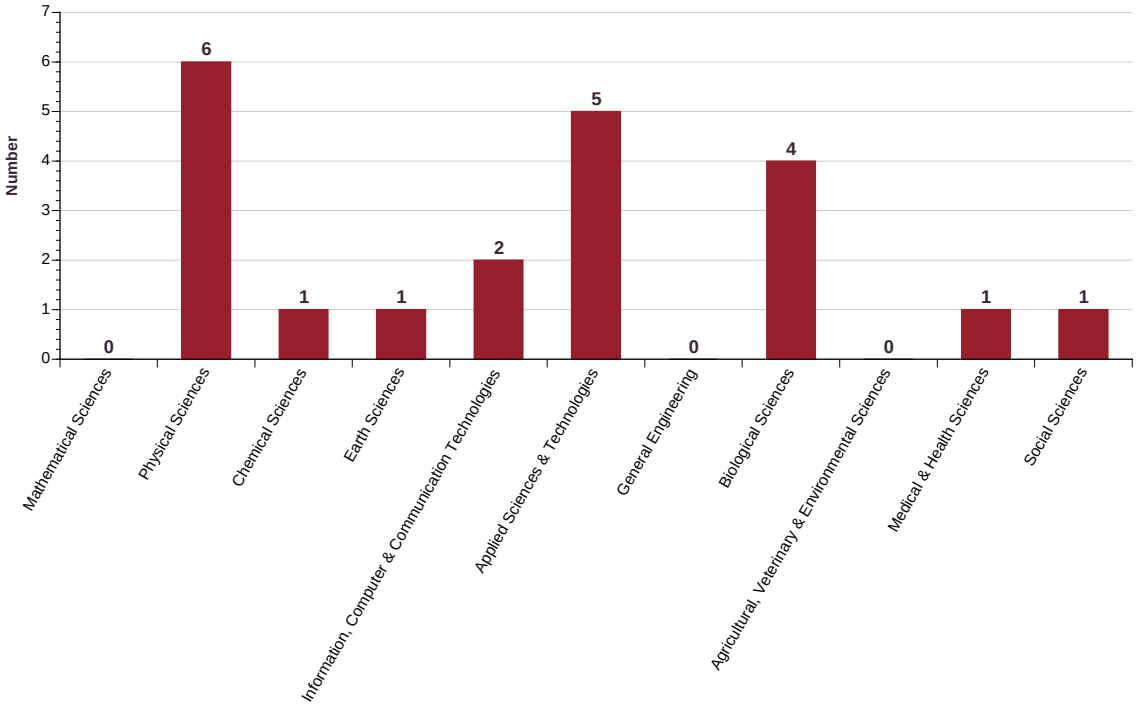
ARC FEDERATION FELLOWSHIPS – EXPENDITURE BY COUNTRY



Source: The Allen Consulting Group
Notes: 1. 2002 Federation Fellowships
2. **Other**: Israel, Panama, Russia, Canada
3. **Other EU**: Denmark, Austria, Spain

Figure A41

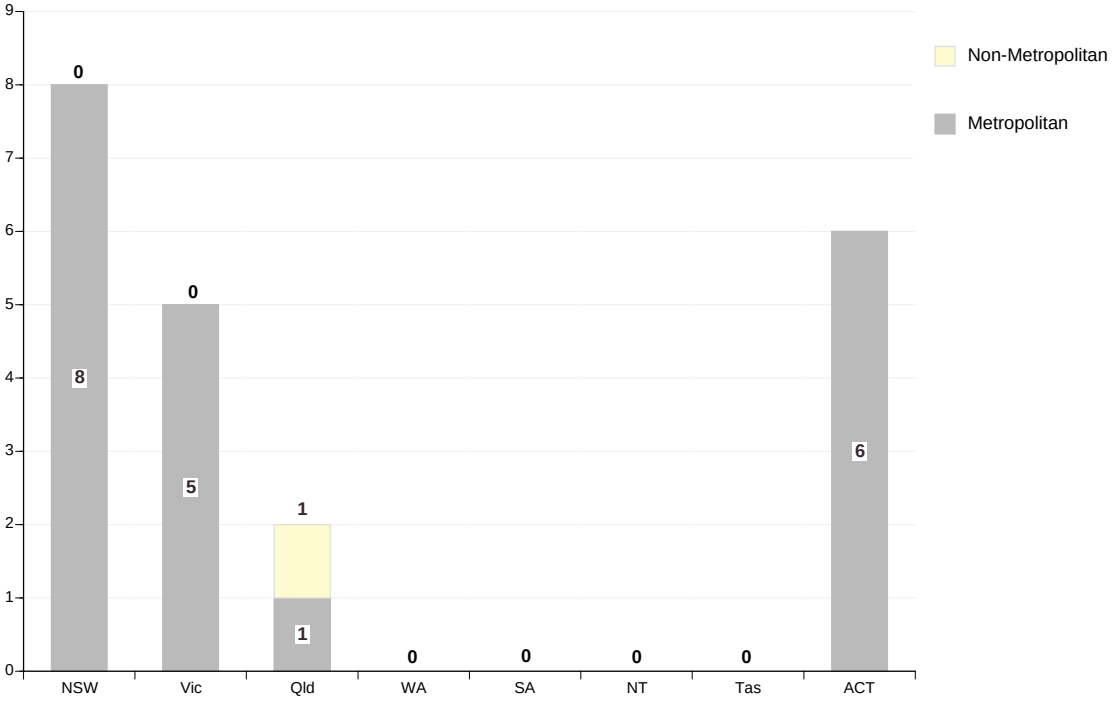
ARC FEDERATION FELLOWSHIPS – ACTIVITIES BY FIELD OF RESEARCH



Source: The Allen Consulting Group
Note: 2002 Federation Fellowships

Figure A42

ARC FEDERATION FELLOWSHIPS – RESEARCHERS BY GEOGRAPHIC LOCATION



Source: The Allen Consulting Group
Note: 2002 Federation Fellowships

A8.4.4 Linkage

The Linkage Program consists of six sub-programs, which support collaborative research between higher education researchers and industry. Funding can be provided for project costs as well as through an Australian Postdoctoral Fellowship (Industry) (APDI) and/or an Australian Postgraduate Award (Industry) (APAI). Grants must be matched dollar-for-dollar with an industry contribution in funds or in kind.

The Linkage program explicitly targets international collaborations with the key objective to:

- encourage and extend cooperative approaches to research by strengthening links within Australia's innovation system and with innovation systems internationally. (ARC, Annual Report 2001-2).

In the annual report, the ARC identifies the outcome of the Linkage program as the ability to fully capture the economic, social and cultural benefits of research at the regional, national and international level.

Four of the six Linkage sub-programs have international components for which information for characterising international activities is available. The programs are described below.

- *Linkage–Projects* — supporting collaborative research projects between higher education researchers and industry with a requirement of dollar for dollar industry matching. Grants cover costs including the salary of an Australian Postdoctoral Fellow.

- *Linkage–International (LI)* — providing Fellowships for one year of funding and Awards for one to three years of funding. Funding is provided for movement of researchers between Australian research institutions and centres of research excellence overseas.

Fellowships are granted only to those overseas researchers whose countries have governing bilateral agreements with the ARC. Fellowship holders are funded for one year and hosted by an Australian based Chief Investigator (CI) and can be either Early Career Researchers or senior researchers.

For LI awards, the first-named Chief Investigator at an Australian-based institution (university or CSIRO) must be a CI on at least one current grant under the Linkage or Discovery programs (or an earlier version of these programs). Preference may be given to countries with which Australia has a Memorandum of Agreement (see the ARC website) or with which Australia has traditional links – US, UK, Canada, NZ and India. Australian researchers currently employed overseas are encouraged to use the LI program to maintain and develop Australian-based colleagues. Normally awards fund Australians to travel abroad and/or the subsistence costs of visitors while they are in Australia.

- *Linkage–Infrastructure Equipment and Facilities* — supporting the purchase of equipment and the development of research facilities.

- *Special Research Initiatives* — encouraging collaborations and supporting the establishment of international research linkages.

A8.4.5 Linkage–Projects Analysis

In 2002 there were 1,481 new and ongoing grants with $77.1m in ARC funding and $93.2m pledged in matching funds by industry. Of this total 470 were new grants. In 2002, the 470 new Linkage-Projects received funding of $25.9m.

The success rate for new grant applications was 51.6 per cent. Within the new grants, new researchers classified as APAIs (Australian Postgraduate Award–Industry).totalled 397 and APDIs (Australian Postdoctoral Fellowship–Industry) totalled 32, however, there is no available project level data for analysing these grant recipients separately.

Almost one fifth of all Linkage–Projects grants involved international collaborations in 2002 leading to 356 active international collaborations with 28 different countries for Linkage grants in 2002.

- This estimate of 356 collaborations is based on the 470 new grants in 2002. For these new grants there were 33 projects for which there was an international Partner Investigator (PI) and an additional 45 for which there were overseas collaborators for a total of 78 grants or 17 per cent of all new grants. For these 78 grants, 113 international collaborations were identified with 28 countries. Applying the 2002 share of international grants (17 per cent) and the implied ratio of 1.45 international collaborators per grant to ongoing grants gives an estimated total of 356 collaborations.

Figures A43 and A44 indicate that, as for ARC grants in total, the top six countries, or country groups, dominate and in this case account for 75 per cent of expenditures. What is striking is that the US and UK together are estimated to represent one half of all collaborative expenditures. As for Linkage International (LI), shown below, the US, UK, Germany, Canada and France dominate collaborations. However, France is not a major partner in terms of expenditure as it is for LI where France ranks first for expenditure. For expenditure on Linkage grants, the share of France is so small it is listed under 'Other EU' because it totals less than two per cent on its own.

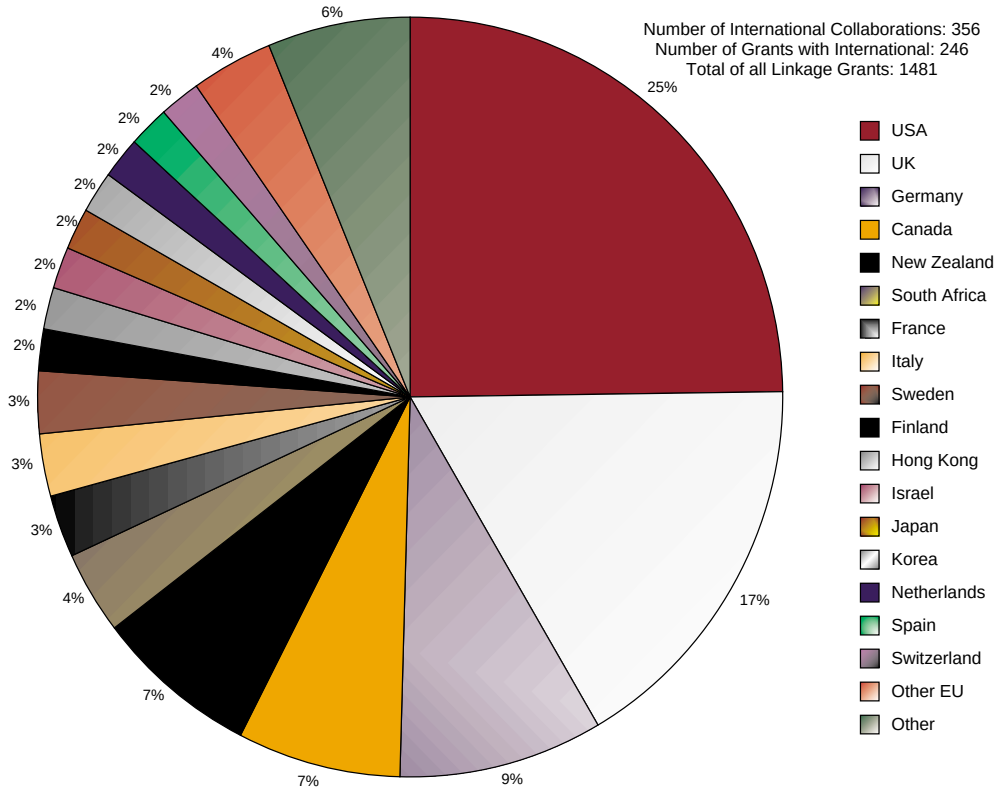
Korea is a major partner for both the LI and Linkage programs (shown below) ranking in the top four in terms of expenditure for Linkage and the top six in LI. Japan and China have a significantly lesser share of the Linkage collaborations and expenditure than for LI. NZ ranks in the top five for LI and yet is a minor Linkage partner.

As illustrated in Figure A45, the international collaborations identified for Linkage grants are more heavily represented in the Biological, Agricultural and Social Sciences than for Discovery grants or all ARC grants in total. Physical Sciences are less well represented than for both ARC grants overall and for Discovery grants.

As for Discovery grants, three is insufficient data to fully analyse Purpose of Research and Geographic Location of Researchers. It is assumed that all 246 grants with international collaborations were 'researcher-to-researcher' collaborations. These are included in the summary figures for the ARC — Figures A29 to A33.

Figure A43

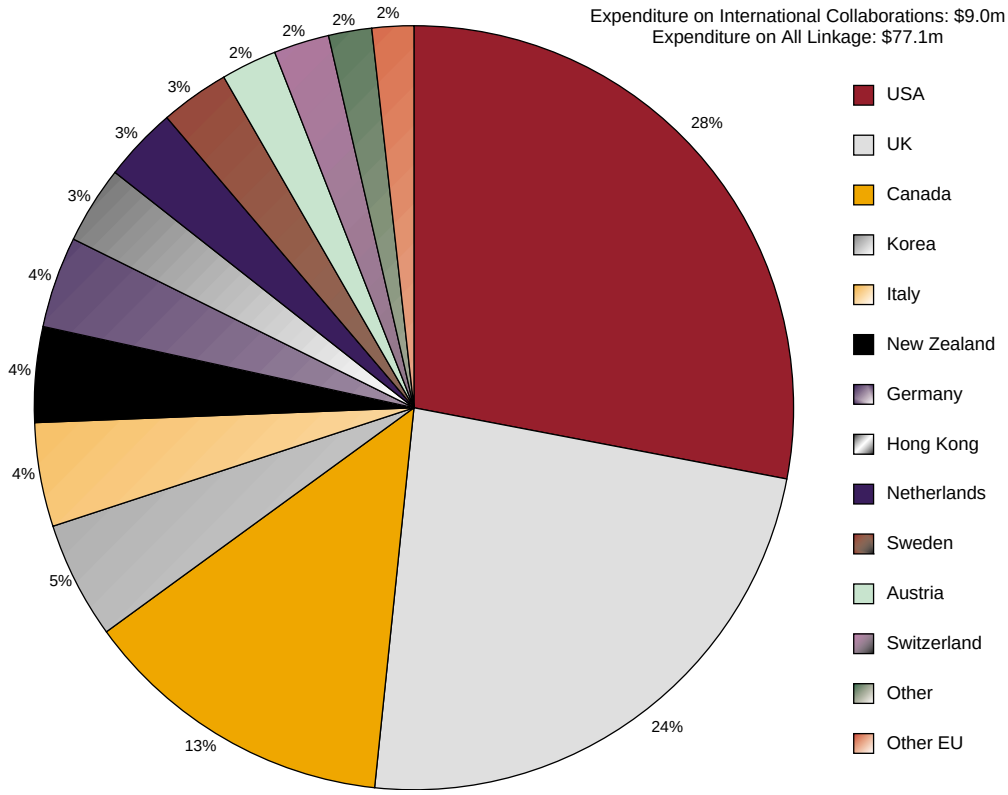
ARC LINKAGE PROJECTS - COLLABORATIONS BY COUNTRY



Source: The Allen Consulting Group
Notes: 1. **Other EU**: Austria, Belgium, Denmark, Portugal
2. **Other**: Brazil, China, India, Mexico, Norway, Russia, Singapore

Figure A44

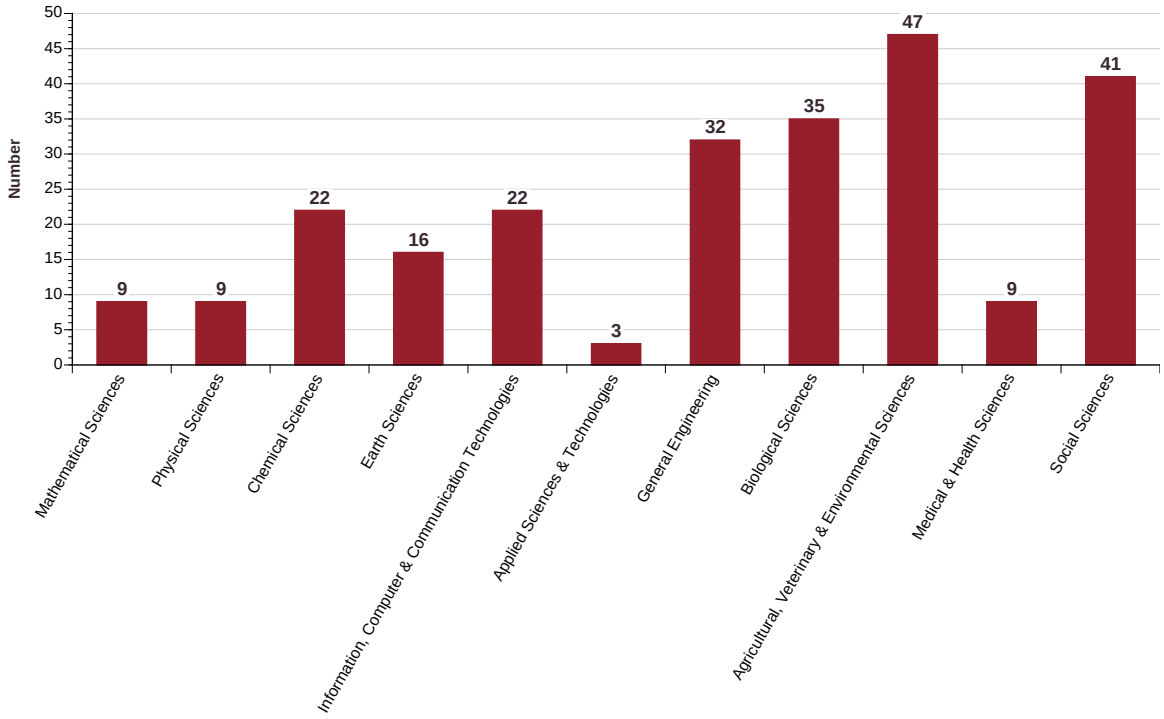
ARC LINKAGE PROJECTS - EXPENDITURE BY COUNTRY



Source: The Allen Consulting Group
Notes: 1. **Other EU**: France, Finland, Spain, Denmark, Belgium, Portugal
2. **Other**: Japan, South Africa, Russia, China, Israel, India, Mexico, Singapore, Brazil, Norway

Figure A45

ARC LINKAGE PROJECTS - ACTIVITIES BY FIELD OF RESEARCH

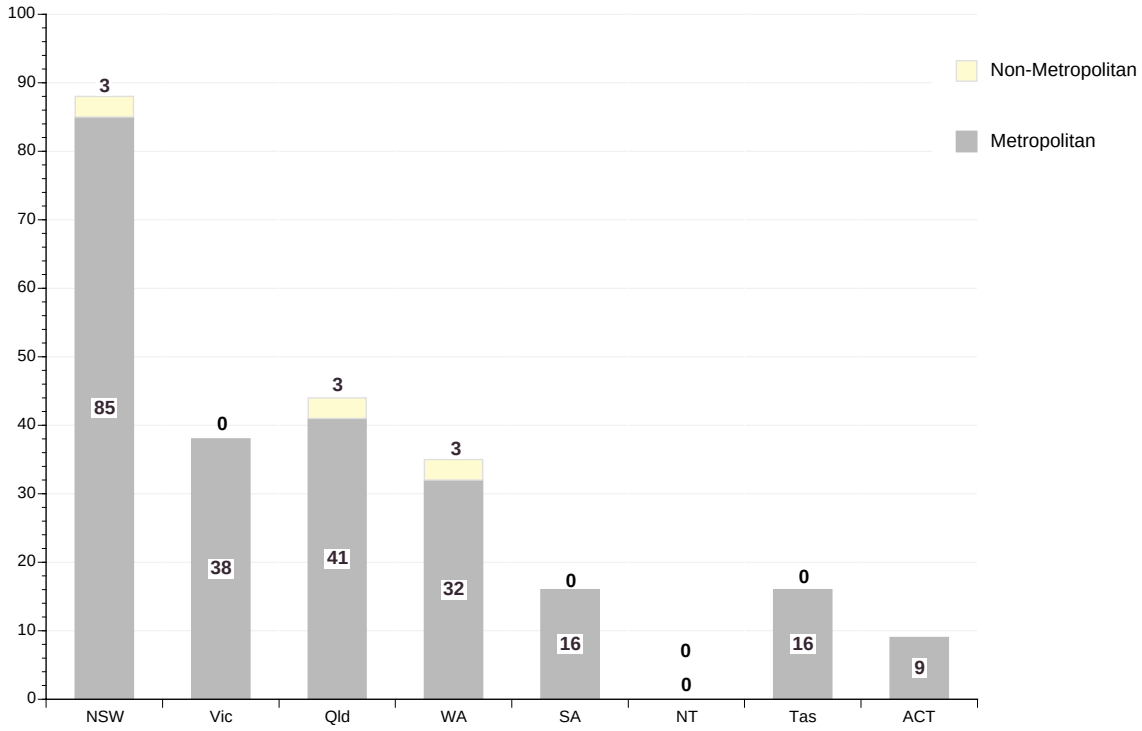


Source: The Allen Consulting Group

Figure A46 illustrates that grant recipient organisations were distributed similarly in Australia to Discovery grants with a relatively smaller share going to Victoria and the ACT and a relatively larger share going to Queensland and Tasmania.

Figure A46

ARC LINKAGE PROJECTS - RESEARCHERS BY GEOGRAPHIC LOCATION



Source: The Allen Consulting Group

A8.4.6 Linkage-International Analysis

In 2002 there were 12 new Fellowships and 54 new Awards granted for a total of $1.5m. The success rate for Fellowships was 54.5 per cent and 81.8 per cent for Awards. Total expenditure in 2002 was $2.7m including $1.2m for 80 ongoing Awards. There were 134 active awards in 2002, plus 12 Fellowships for a total of 146 Linkage-International grants. In 2002, $751,641 was awarded for 12 new Fellowships and $751,166 was awarded for 54 new Awards.

Figures A47 to A51 provide details for Linkage–International grants based on the analysis of new grants in 2002. As for Linkage-Projects, the 2002 distributions to scale up for the on-going 80 grants were used. For the 146 grants represented in the figures, 210 collaborations are estimated to have taken place with 20 countries. Six of the 20 collaborating countries account for almost 75 per cent of all collaborations and total expenditure. Most of the collaborations were with the US (18 per cent) while France (16 per cent) and the UK (13 per cent) ranked second and third, respectively.

Most of the grant funding was spent in collaborations with France US, UK, China and Germany ranking next. Care should be taken, however, in making comparisons between Figure A47 (number of collaborations) and Figure A48 (expenditure on collaborations). The ranking by expenditure is not expected to match the ranking by number of collaborations for a number of reasons.

- The relatively higher share of expenditures for France than for the US, for example, may reflect a relatively greater number of collaborators in relatively higher cost projects than for the US.
- There may be fewer collaborators from other countries where there are collaborations with France. In other words, the US may be involved in relatively more projects where there are many collaborators and this lowers the average expenditure per collaborating country involved.

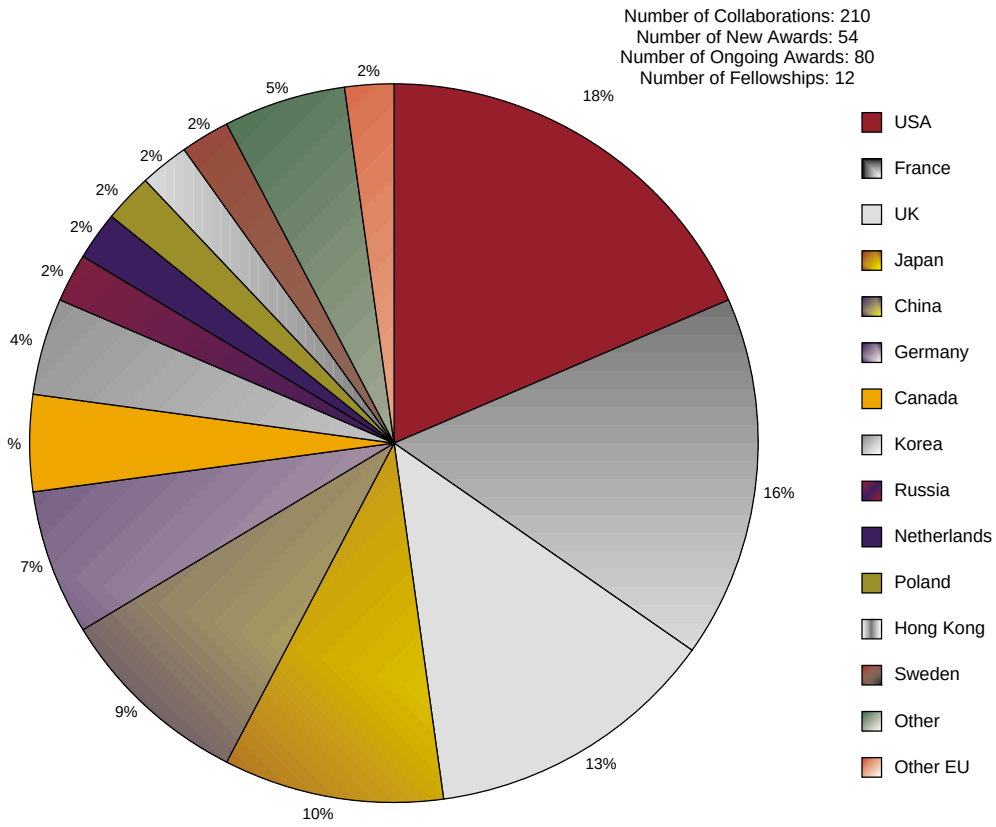
Figure A49 illustrates that approximately one-third of the collaborations are concentrated in the two fields of Physical Sciences and Applied Sciences and Technologies with the remaining one-third spread over the remaining fields.

Based on the grant descriptions provided on the ARC Website, the Purpose of Research for this program is predominantly 'researcher-to-researcher' collaboration and 'exchanges'. This result is expected given the requirements of this program (Figure A50). Data limitations restricted further analysis.

All but 18 new 2002 grant descriptions available on the ARC Website were reviewed to identify where the Australian researchers were located at the time of application. These estimates were used to scale up for the on-going 80 grants. Figure A51, summarises this review, showing that research activity covered by this grant program is estimated to have been concentrated in New South Wales and capital cities with the majority going to Sydney. It is estimated that there were 175 researchers collaborating on the total of 134 grants active in 2002.

Figure A47

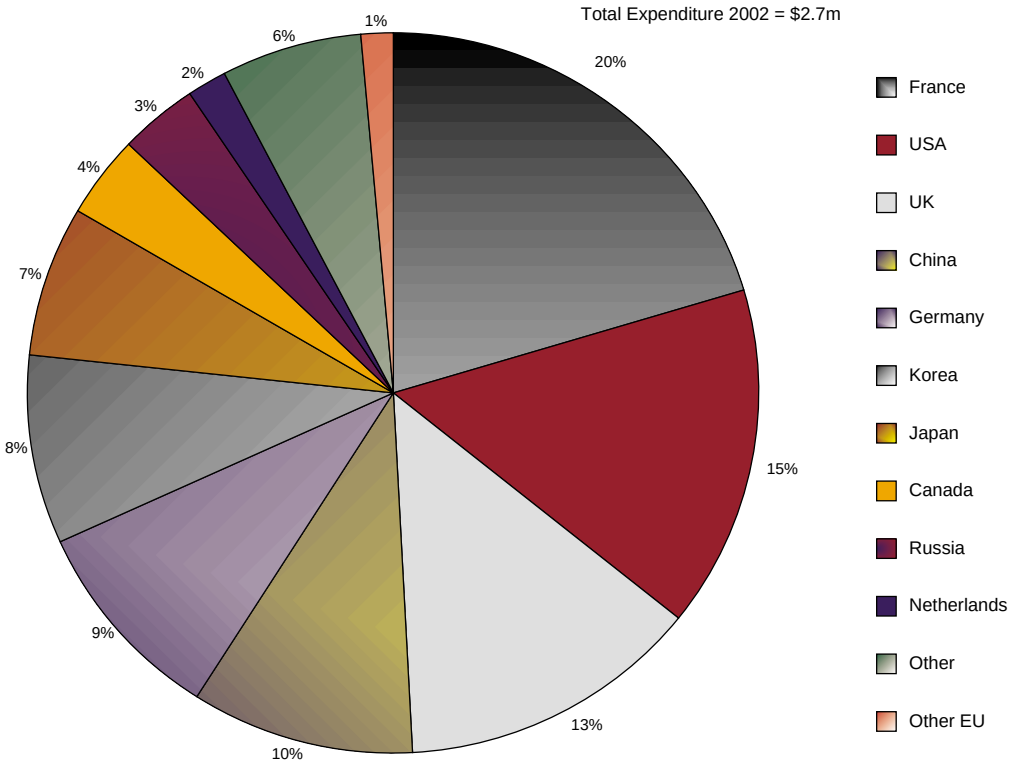
ARC LINKAGE - INTERNATIONAL S&T COLLABORATIONS BY COUNTRY/ECONOMY



Source: The Allen Consulting Group
Notes: 1. **Other**: India, Taiwan, Philippines, South Africa, NZ.
2. **Other EU**: Finland and Italy.

Figure A48

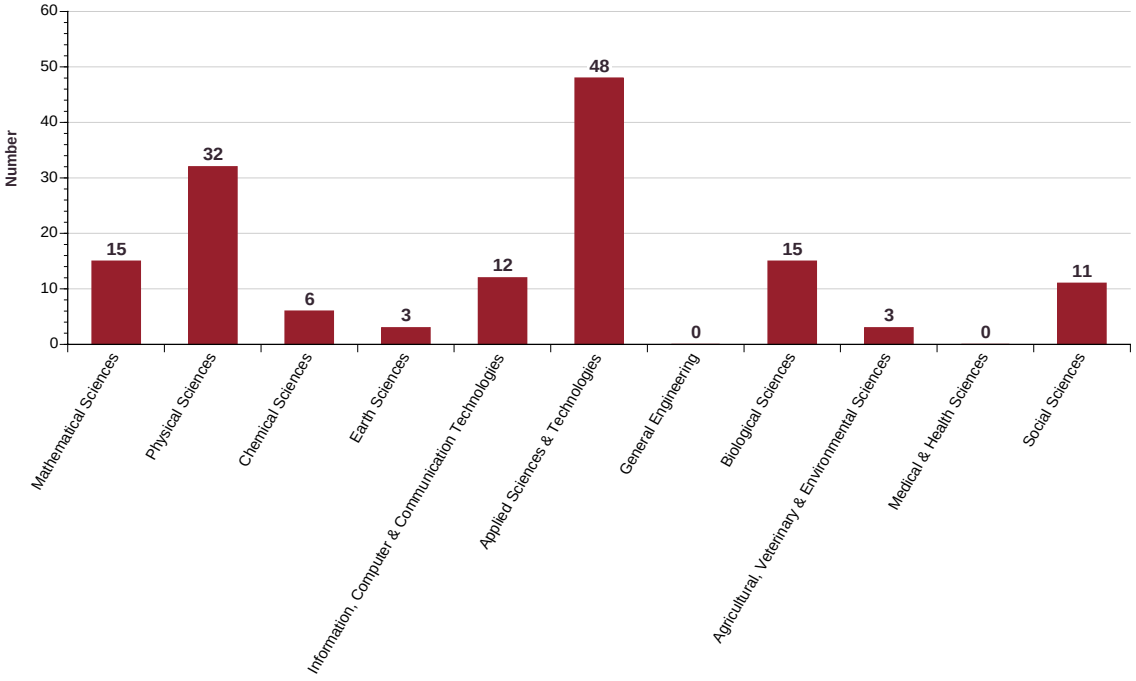
ARC LINKAGE - INTERNATIONAL EXPENDITURE BY COUNTRY/ECONOMY



Source: The Allen Consulting Group
Notes: 1. **Other**: India, Poland, Taiwan, Hong Kong, Philippines, South Africa, NZ
2. **Other EU**: Sweden, Finland, Italy

Figure A49

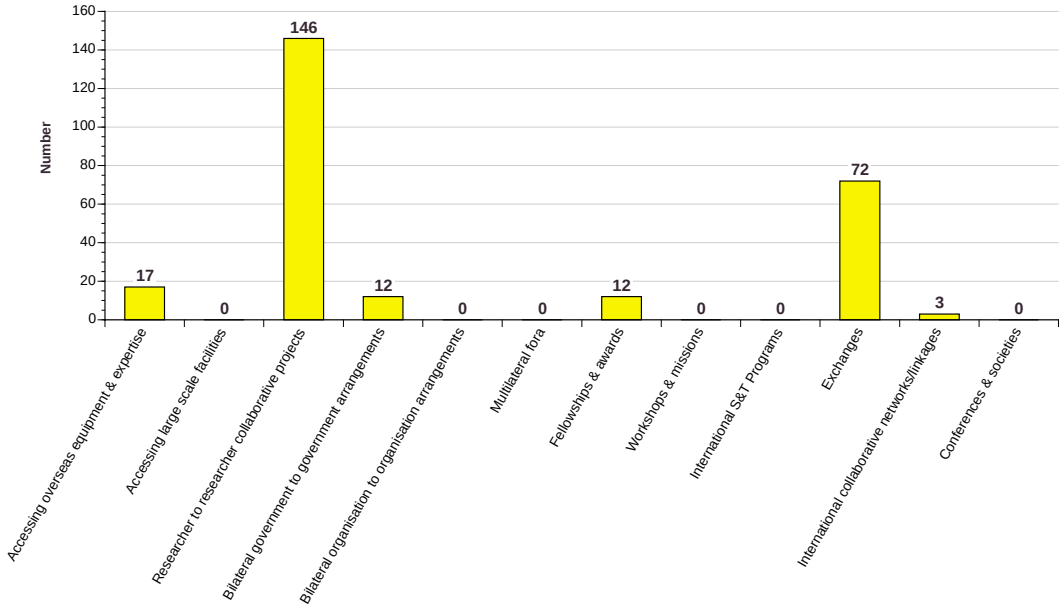
ARC LINKAGE - INTERNATIONAL ACTIVITIES BY FIELD OF RESEARCH



Source: The Allen Consulting Group

Figure A50

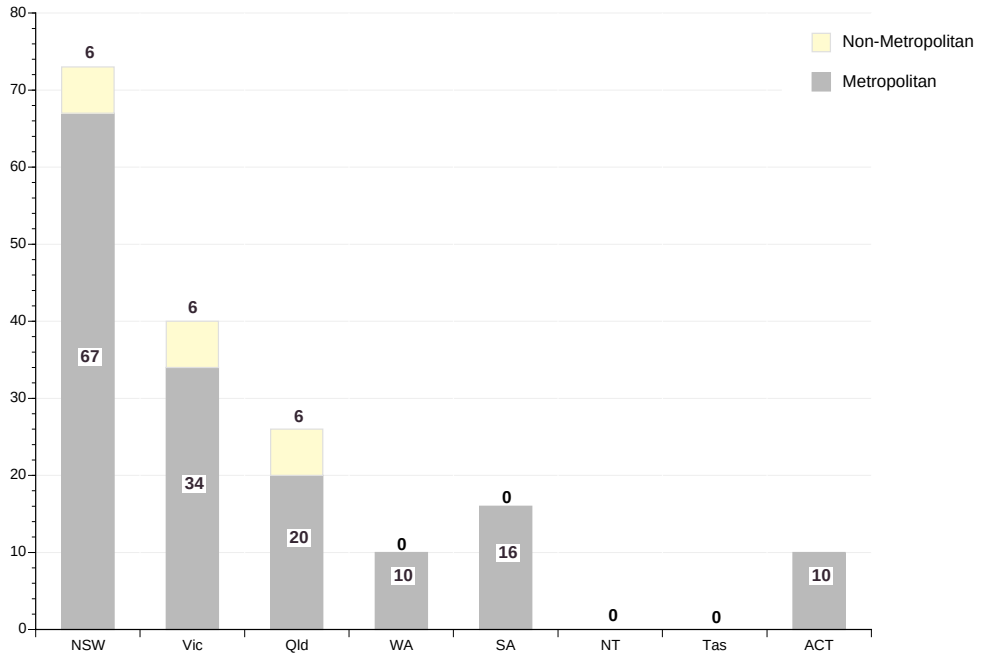
ARC LINKAGE - INTERNATIONAL ACTIVITIES BY PURPOSE AND TYPE



Source: The Allen Consulting Group

Figure A51

ARC LINKAGE INTERNATIONAL – RESEARCHERS BY GEOGRAPHIC LOCATION



Source: The Allen Consulting Group

A8.4.7 Linkage–Infrastructure Analysis

Linkage-Infrastructure grants are provided for one year only and in 2002 there were 70 grants totalling $27.2m. The success rate of applications was 54.3 per cent. In its 2001-2 Annual Report the ARC notes that there were 35 projects involving international collaboration, which led to 101 international collaborations with 25 countries and six overseas partners. $3.6m was spent in 2002 on four international research facilities —

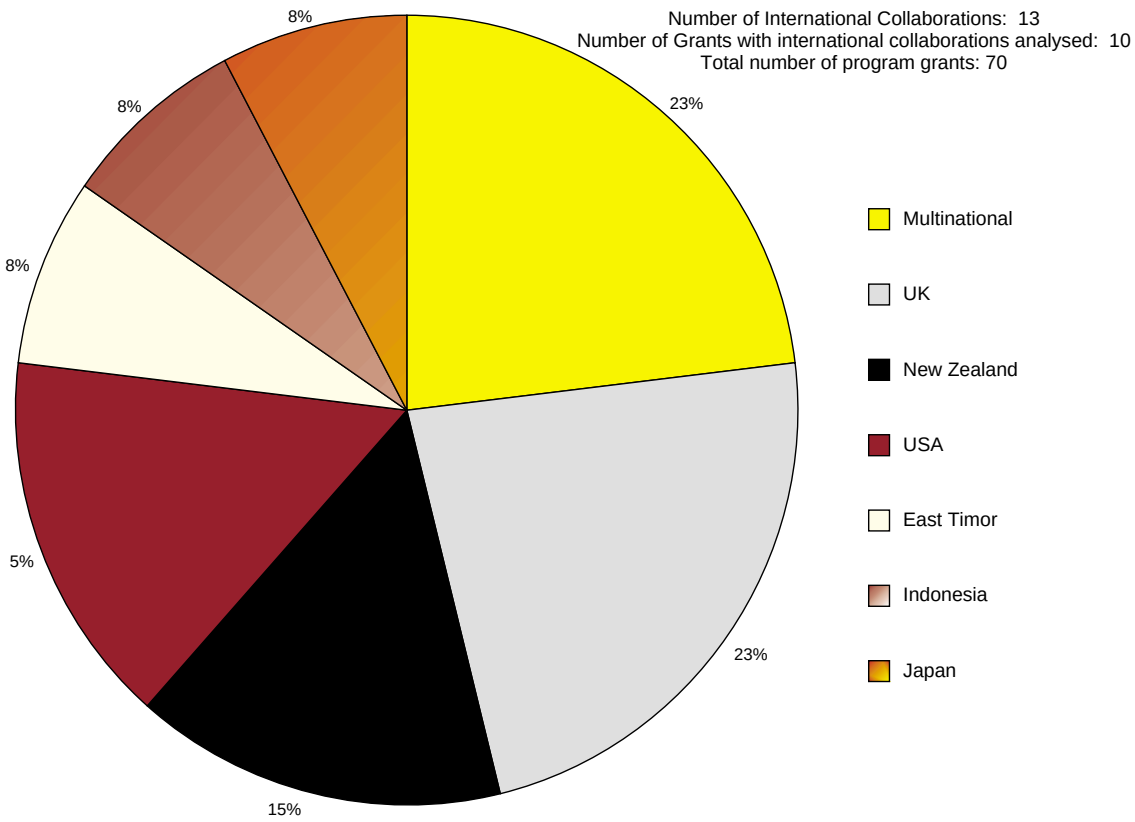
- International Gemini Partnership ($1.6m)
- International Ocean Drilling Program ($1.5m)
- ISIS (intense neutron spallation source) ($250,000)
- Experimental High Energy Physics Program (CERN) ($225,000)

A review of all new grant descriptions on the ARC Website identified 10 grants where international collaborations were explicitly noted. These are characterised in Figures A52 to A56. It is assumed that all 10 of these projects were international in nature and therefore 100 per cent of the expenditures are considered to be international collaborations. The ARC noted that 35 projects involve international collaborations, however, this analysis covers the 10 for which detailed information was readily available on the ARC Website.

Unlike other ARC grants, multinational collaborations dominate this grant category for the 10 grants analysed. These include the four large projects listed above. There were 13 international collaborations noted in the grant descriptions but these include a number of countries collaborating on multinational projects.

Figure A52

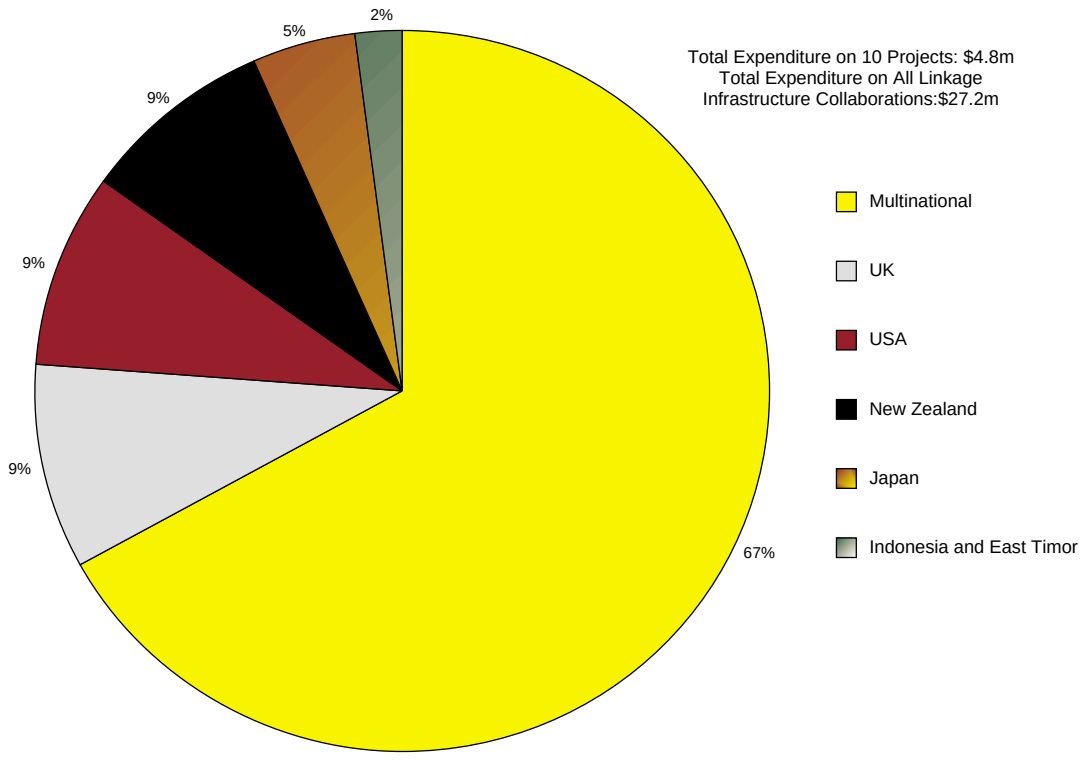
ARC LINKAGE INFRASTRUCTURE - INTERNATIONAL S&T COLLABORATIONS BY COUNTRY



Source: The Allen Consulting Group

Figure A53

ARC LINKAGE INFRASTRUCTURE – EXPENDITURE BY COUNTRY - 10 PROJECTS



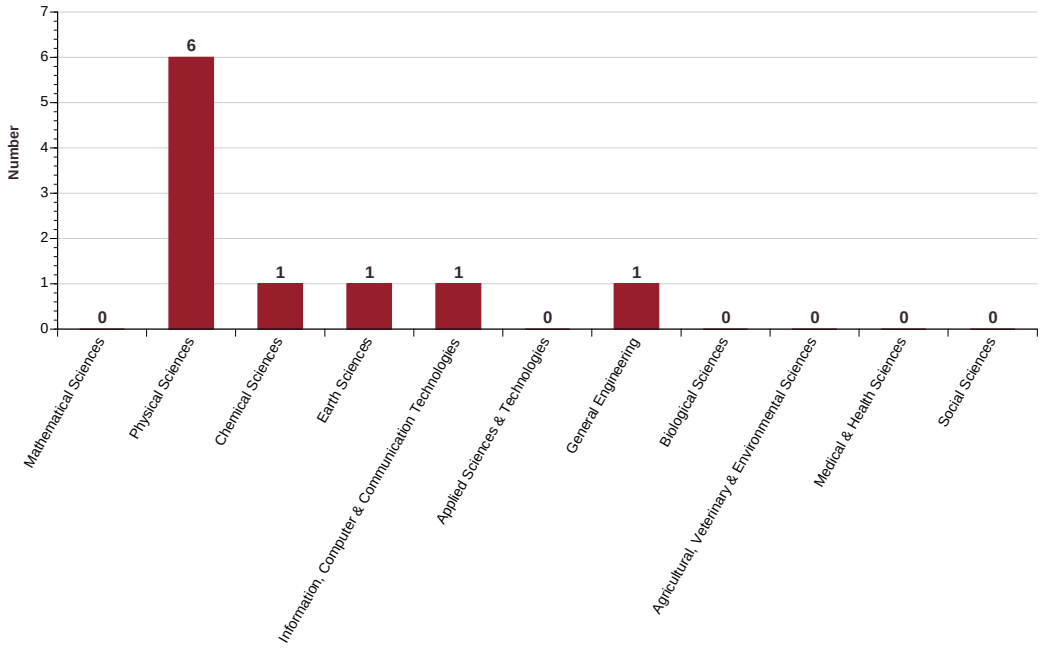
Source: The Allen Consulting Group

The UK, New Zealand, US and Japan represent the large majority of the collaborations. Two thirds of the expenditures are on collaborations with multinational collaborations. Total expenditure on these 10 projects was $4.8m.

Figure A54 illustrates that most collaborations were in the Physical Sciences and Figure A55 illustrates the emphasis on International S&T Programs. Figure A56 illustrates a similar distribution to all ARC grants with researchers concentrated in NSW. Non-metropolitan regions may be under-represented due to lack of data.

Figure A54

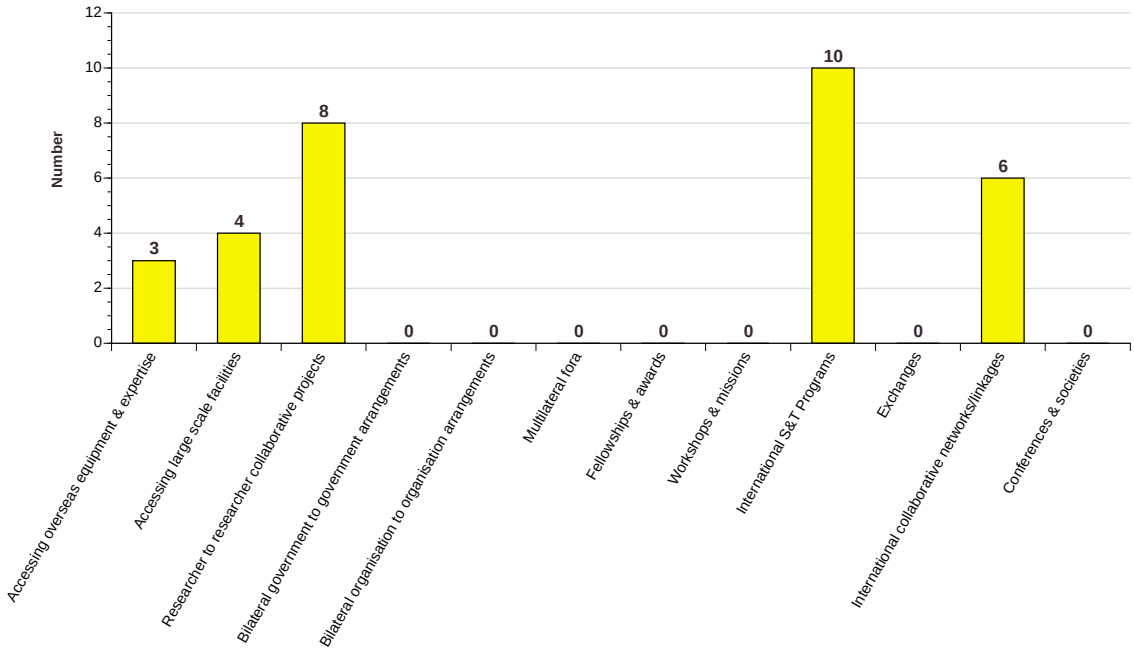
ARC LINKAGE INFRASTRUCTURE - ACTIVITIES BY FIELD OF RESEARCH - 10 PROJECTS



Source: The Allen Consulting Group

Figure A55

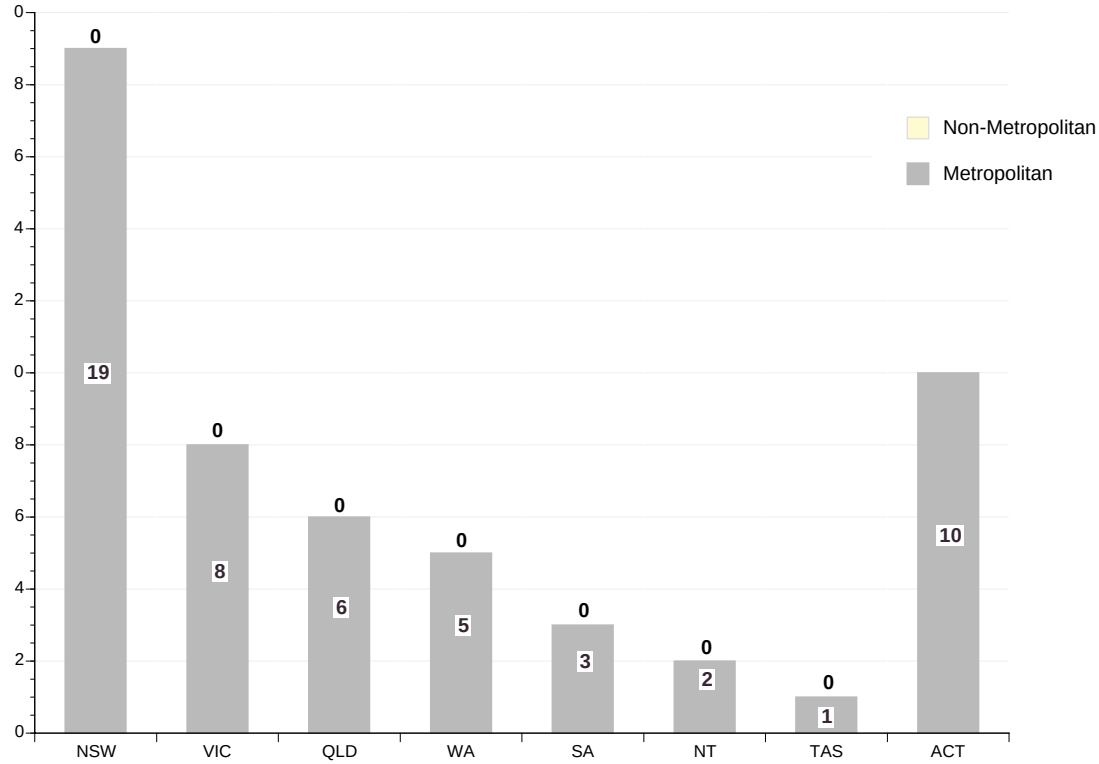
ARC LINKAGE INFRASTRUCTURE - ACTIVITIES BY PURPOSE AND TYPE



Source: The Allen Consulting Group

Figure A56

ARC LINKAGE INFRASTRUCTURE - RESEARCHERS BY GEOGRAPHIC LOCATION



Source: The Allen Consulting Group

A8.4.8 Special Research Initiatives (SRI) - Analysis

The ARC contributed $73,304 to Australia's membership of the Global Biodiversity Information Facility (GBIF). GBIF is an international scientific partnership aimed at facilitating the exchange of biodiversity information through the establishment of a network of biodiversity databases from around the world. Australia is a signatory to the 2001 international Memorandum of Understanding governing the development and operation of the GBIF. DEST, CSIRO, Environment and Heritage and the NHMRC also contribute to the membership for Australia. The characteristics of the GBIF expenditures are reflected in the ARC summaries provided above in Table A7 and Figures A29 to A34.

A8.5 Data

For this study, the Review Team met with ARC staff and discussed the most effective way to access the ARC data holdings within the limited time and resources available. It was agreed that ARC staff would provide data extracts for the major ARC schemes (Discovery-Projects and Linkage-Projects) while the Review Team would access available data for smaller ARC schemes from the ARC Website.

The ARC provided spreadsheets that summarised characteristics of grant data for new 2002 Linkage–Projects and Discovery–Projects. These data represented a subset of total grant data including only those grants for which ARC staff had identified international collaborations. Grant data for Federation Fellowships, Linkage-International, Linkage-Infrastructure and Special Research Initiatives were found on the ARC Website and the *ARC Annual Report 2001-02*. ARC staff provided additional information on the Linkage International Program.

Although this study has drawn on the material provided by the ARC and sought ARC staff advice throughout the analysis, in some cases, the summary statistics vary slightly from the ARC Annual Report. This is so for a few reasons including the following:

- For the analysis of S&T collaborations, wherever possible, the grants made in the Law and Humanities fields were excluded. However, total grant amounts noted for comparison purposes, do include all grants, which include grants made in these fields.
- The broad fields of research for the Australian Bureau of Statistics Standard Research Classification codes have been used for this study. Since the ARC uses the finer, 1998 version, of the ASRC Research Field classifications, in some cases, grants were grouped by the Review Team. This is the case for Social Sciences where, for example, Economics and Behavioural and Cognitive Sciences were grouped under ASRC code 11, Social Sciences.
- Although the ARC documents cases where Early Career Researchers (ECRs) receive grants, time constraints and data constraints for the subset of data used here precluded analysis of ECRs at this time. However, analysis of the funded international activities by ECRs is an area for future investigation.
- The Review Team analysed the data and estimated international shares. Where there was an overseas Partner Investigator (PI), it was agreed with the ARC staff that this grant would be characterised as 100 per cent international. Where there was no overseas PI, but there were overseas researchers involved, it was assumed that the international share of expenditure was 10 per cent. Without detailed grant information combined with improved reporting by grantees on international collaborations, any estimate is somewhat arbitrary. This is discussed further under program details and below under data issues.
- The ARC grant databases provided do not characterise grants by purpose and type of research. Where possible, and where information is available, the purpose of the grants has been characterised to be 'fellowships' and 'researcher–to–researcher' collaborations as well as 'accessing overseas expertise'.
- As outlined below for each program, the Review Team relied on grant summaries provided on the Web to characterise grants for Linkage–International Fellowships and Linkage-Infrastructure. In some cases, from the point of view of the needs for this study, the Website provided insufficient detail. Where these limitations have been important, they are noted throughout the text.

A8.6 Methodology

A8.6.1 Estimating the International Expenditure Share of Linkage and Discovery Grants

For the ARC grant data, there are two stages involved in characterising the international collaborations. In the first stage, the share of international collaborations for new grants in 2002 is estimated. In the second, the share of international collaboration involved in ongoing grants is estimated. The process is described below.

For the Linkage International program, all grants require international collaborations and the purpose of the program is to promote these collaborations. For this reason, the total expenditure on grants is characterised as international. For Linkage and Discovery grants, there is no requirement for international collaborations; however, the ARC collects some information on international collaborations. The information provided by the ARC was used to estimate the extent of the international collaborations. As for the National Health and Medical Council (NHMRC), discussed in Appendix C, estimates for the ARC were based on new grants starting in 2002.

The ARC provided data in spreadsheets for Discovery and Linkage Awards granted in 2001 to start in 2002. Two sets of data were provided. One set included all grants for which there is an overseas Partner Investigator (PI). The second set included grants for which there is an overseas collaborator but no overseas PI.

The procedure for estimating the expenditure on international collaborations is based on the following assumptions with a discussion following.

- The expenditure on international collaborations is estimated at 100 per cent where there is an overseas PI.
- The share of expenditure on grants where there are international collaborations but no overseas PI is estimated at 10 per cent.
- Expenditure on international collaborations is allocated equally to each collaborating country.
- The distribution of collaborations for ongoing grants is the same as the distribution for new grants starting in 2002.

As agreed with the ARC grants where there is an overseas PI were counted as 100 per cent international. This assumption is based on the ARC criterion, which categorises a PI as a major partner in the collaboration.

For Linkage and Discovery Awards where there is at least one overseas collaborator, but no overseas PI, it was necessary to make assumptions about how much of the total expenditure could be attributed to the international collaboration. Since there is no overseas PI, it was assumed that the international collaboration is something less than 100 per cent but there is insufficient information on the ARC grants to estimate the extent of the international collaborations for this set of data. It was assumed that 10 per cent of the total value of grants with some international collaborations is the international portion.

This assumption is based on the analysis of individual NHMRC grants where it was estimated based on detailed grant analysis that, on average, 10 per cent of the value of the NHMRC grants expenditure was allocated to international collaborations in 2002.[61] Without evaluating complete, individual ARC grant applications, it is not possible to provide an estimate of the share of the value of these grants that can be attributed to international collaborative efforts. Given time and resource constraints, NHMRC analysis was relied upon. However, given this 10 per cent assumption, the international share of collaborations may indeed be greatly under-estimated, or even over-estimated.

[61] For the sample analysis of NHMRC Project grants where there were no overseas Chief Investigators, the total grant expenditure was divided equally among the investigators and the portion attributed to international collaborations was estimated from this. For example, a $100,000 grant with 10 investigators, including one overseas investigator, was counted as an international collaboration of $10,000.

Total 2002 expenditure on international collaborations for Linkage and Discovery grants is estimated as the sum of the estimate for new 2002 grants and ongoing grants. To estimate ongoing grant expenditures, the expenditure shares for international collaborations for 2002 grants with an overseas PI and 10 per cent of the grants with an overseas collaborator were applied to the expenditure on ongoing grants. To characterise the total 2002 expenditure by country, the distributions for the new, 2002 grants were applied to on-going grants.

The figures for the ARC grant programs are based on these assumptions and should be carefully interpreted. The total expenditure in 2002 is reflected here but the distributions are based on the distributions for 2002. This assumption is better the higher is the share of new grants in total grants. The share of new grants in total expenditure is 34 per cent for the Linkage Program, 39 per cent for Discovery and 65 per cent for Linkage International Awards suggesting that estimated distributions are likely to be best for the Linkage International Program and least reliable for the Linkage Program.

A8.6.2 Estimating the Number of International Collaborations

The total number of international collaborations for Linkage and Discovery grants is estimated in a two-step process based on the shares for 2002 new grants. In the first step, the number of grants that had international collaborations is identified. This share is then applied to the total for on-going grants to estimate the number of on-going grants with international collaborations. For example, of new Discovery grants, 366 had international collaborations, which represented almost one half (47 per cent) of the 786 new grants. Assuming that current shares apply to past shares, it was estimated that one half (662) of the 1406 ongoing grants had international collaborations. As indicated in Figure A33 the estimated total is 1028 grants with international collaborations.

In the second step, the number of collaborations was estimated from the number of collaborations associated with new 2002 grants. For example, the ARC project data set indicated that there were 746 collaborations associated with the 366 new Discovery grants in 2002. On average, therefore, it was estimated that each grant with international collaborations had two collaborations. Applying a factor of 2.03 to ongoing grants results in an estimate of 2,080 collaborations represented by the 1,028 Discovery grants active in 2002.

The same method is used for Linkage–Project grants. In 2002 there were 1481 active grants. The 2002 new grant data indicates that 17 per cent (78) of new grants have international collaborations, which is much less than the 47 per cent for Discovery grants. For Linkage–Projects, it is then estimated that 167, or 17 per cent of the 1011 on-going grants had international collaborations. Hence, total estimated grants with international collaborations are 246. For new 2002 grants the data indicate that on average, each grant had 1.5 collaborations for a total for new grants of 113. Hence, it is estimated that there are resulting in an estimate of 113 new collaborations and 243 on-going collaborations for a total of 356 collaborations associated with 1481 active grants.

A9 Commonwealth Scientific and Industrial Research Organisation

The Commonwealth Scientific and Industrial Research Organisation (CSIRO) is one of the world's largest and diverse scientific research organisations with 6,500 staff in 65 sites, three overseas laboratories and seven other international locations. According to the *CSIRO International Annual Report 2002*, there is a rich history of international collaboration with over 750 current or recently completed projects and an associated 1,420 collaborations with more than 80 countries. CSIRO has extensive experience in undertaking collaborations with developing countries especially in Asia and close ties with the scientific community in the US, Europe and Japan.

According to the *CSIRO 2002 International Annual Report*, almost one third of CSIRO's international activity is collaboration with leading scientific organisations and companies in the US and another third is with scientifically advanced organisations and firms in Europe and Japan. The remaining third of the international activity is with developing countries, particularly in the Pacific and Africa, mostly funded through Australian aid programs. Most of the work in developing countries is in agricultural development, forestry, marine science and aquaculture, water and environmental management.

Of the 1,420 international collaborations active over the two year period 2000-2, the majority were with the US at 259 collaborations with most in Plant Industry, Telecommunication Industrial Physics and the Australia Telescope National Facility (ATNF). The next most significant international collaborator was Japan with far few activities, at 94, again with an emphasis on Telecommunication Industrial Physics, Plant Industry[62] (see Figure A57).

Figure A58 illustrates the distribution of activities undertaken in the new international projects undertaken in 2002. Most of the activity took place in collaborations with the US with Japan, Thailand and Indonesia each at approximately half the activity level of the US. Also illustrated is the distribution of activity according to type of activity. Most of the activity is in collaborative research with significant shares of training and licensing. The share of activity in consulting activities reflects the consulting role CSIRO performs as part of its responsibility to generate its own operating revenue.

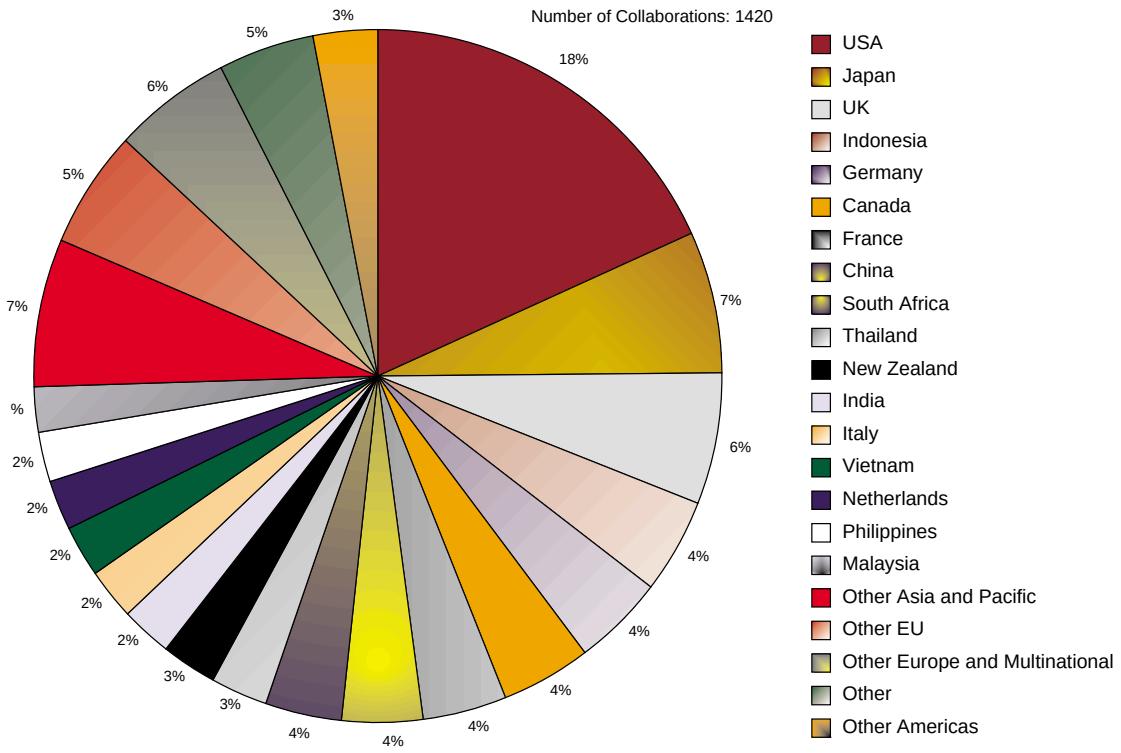
CSIRO was not able to provide expenditure data on international S&T by year, as CSIRO's international database does not record this level of information. Analysis of the database leads to two conclusions: CSIRO gets much of its international activities paid for by non-Commonwealth Government sources and the largest expenditure by CSIRO in relation to international S&T is the time that CSIRO staff work on these activities.

Not only is researcher time very difficult to measure, but in 2001-2 CSIRO did not have a time keeping system in operation. It would be reasonable in an organisation such as CSIRO to estimate (conservatively) that staff would spend ten per cent of their time on activities that could be classified as international S&T. Ten per cent of CSIRO's salary payments in 2001-2 would be $42.2m. In addition, some of CSIRO's other operating costs could probably be attributed to international S&T. A conservative estimate of international expenditure by CSIRO using Commonwealth Government funds would be approximately $40m.

[62] CSIRO International, Annual Report.2002

Figure A57

CSIRO INTERNATIONAL COLLABORATIONS BY COUNTRY/ECONOMY

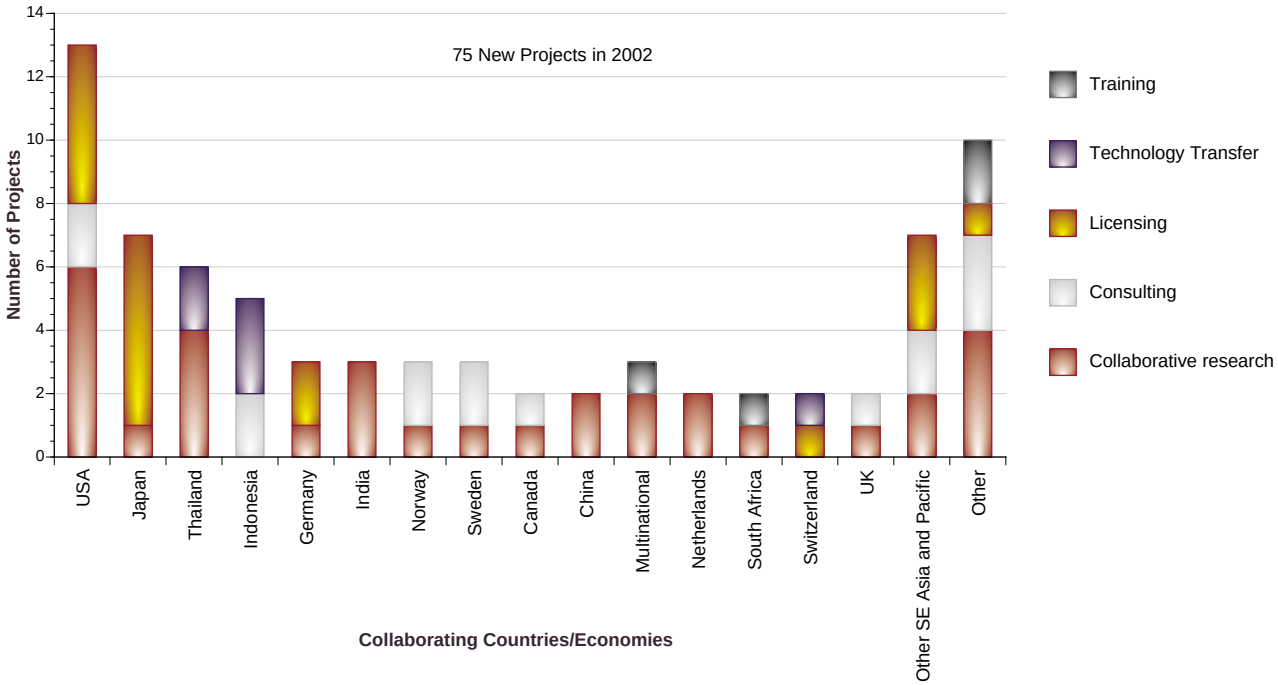


Source: The Allen Consulting Group

Notes:
1. **Other Asia and Pacific**: Taiwan, PNG, Korea, Singapore, Laos, Fiji, Hong Kong, Solomon Islands, Vanuatu, Cambodia, East Timor, Samoa, Tonga, Kiribati, Myanmar, New Caledonia, Western Samoa
2. **Other EU:** Sweden, Finland, Austria, Denmark, Belgium, Spain, Portugal, Greece
3. **Other Europe and Multinational:** Switzerland, Multinational, Norway, Russia, Hungary, Poland, Iceland, Turkey, Slovakia, Slovenia, Yugoslavia
4. **Other:** Bangladesh, Sri Lanka, Kenya, Pakistan, Iran, Iceland, Nepal, Cuba, Nigeria, Syria, Israel, Tanzania, Zimbabwe, Afghanistan, Benin, Botswana, Cameroon, Congo, Ecuador, Ethiopia, Ghana, Iraq, Lebanon, Maldives, Mozambique
5. **Other Americas**: Brazil, Chile, Mexico, Argentina, Peru

Figure A58

CSIRO - PURPOSE OF COLLABORATIONS - 2002 NEW PROJECTS



Source: SIRO International Office and The Allen Consulting Group

Notes:
1. **Other SE Asia and Pacific**: PNG, Korea, Philippines, Solomon Islands, East Timor, Fiji, Taiwan, Vietnam.
2. **Other**: Bangladesh, Chile, Cosa Rica, France, Hong Kong, India, Italy, Kenya, Sri Lanka, Tanzania.

The difficulties in estimating the level and kind of expenditures undertaken at CSIRO are the same as for other research organisations throughout the world that have a similar structure and function to CSIRO. For example, *Nederlandse Organisatie voor Toegepaste* (TNO) in the Netherlands, is similar to CSIRO and provides consulting services, receives funds from industry, national governments and EU governments as well as from other international bodies. While it would provide an excellent comparison for CSIRO in terms of its international collaborative activities, TNO is unable to provide a breakdown of government support for international S&T collaborations.

A10 Australian Nuclear Science and Technology Organisation

The Commonwealth Government, under the Triennium Funding Agreement, supports the Australian Nuclear Science and Technology Organisation (ANSTO), Australia's nuclear research organisation. It operates the Australian High Flux nuclear reactor (HIFAR), the National Medical Cyclotron and the Australian National Tandem Accelerator. ANSTO's annual report for 2001-2 recorded $98.9m in appropriation for operational and capital expenses for S&T activities, and a total of 376 collaborative research projects involving parties external to ANSTO.

A10.1 Overview of Investment in International S&T

ANSTO does not have programs that are specifically designed to conduct international S&T, however, some of its research activities and statutory obligations have an international component. It participates, for example, in regional and international nuclear fora and conducts research on the international implementation of nuclear technology on a secure and safe basis, including the development of standards, guidelines and practices. In particular, ANSTO has a number of science projects in collaboration with the UN's International Atomic Energy Agency (IAEA), and to a lesser extent, with the OECD Nuclear Energy Agency (NEA). It also has a number of bilateral collaborations with nuclear and scientific institutes in the Asia-Pacific, France, Russia, the US and the UK.

A10.2 Analysis

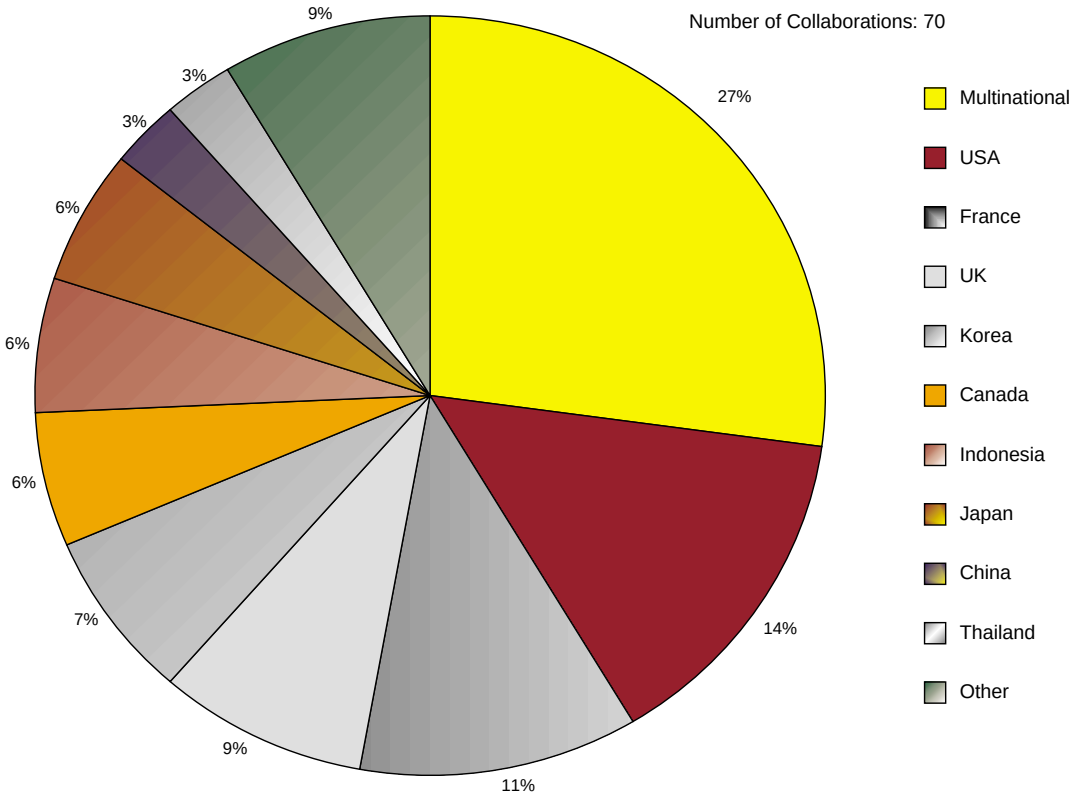
The analysis of ANSTO's international S&T activitiesis based on estimates provided by the organisation and excludes projects directed at service delivery, for example, services regarding nuclear powered warships. This analysis does not include ANSTO's activities in the AMRF as these were categorised as outsourced components of IAP–IST (see A1.3.2).

Twenty-eight projects involving international S&T were analysed, the results of which are shown in Figures A59 to A61. The high proportion of multinational collaborations in Figure A59 reflects ANSTO's participation in multinational fora and organisations, such as the IAEA. Individual countries with whom ANSTO most frequently collaborates are the US, France, the UK and Korea respectively.

It appears that 6 per cent of ANSTO's operational and capital expenditure on S&T is directed at international collaborative S&T. Figure A60, expenditure on international S&T, shows a similar group of top four collaborators: multinational, the US, the UK and France. However, expenditure in the UK is higher than France, and Korea had dropped from fifth to ninth place.

Figure A59

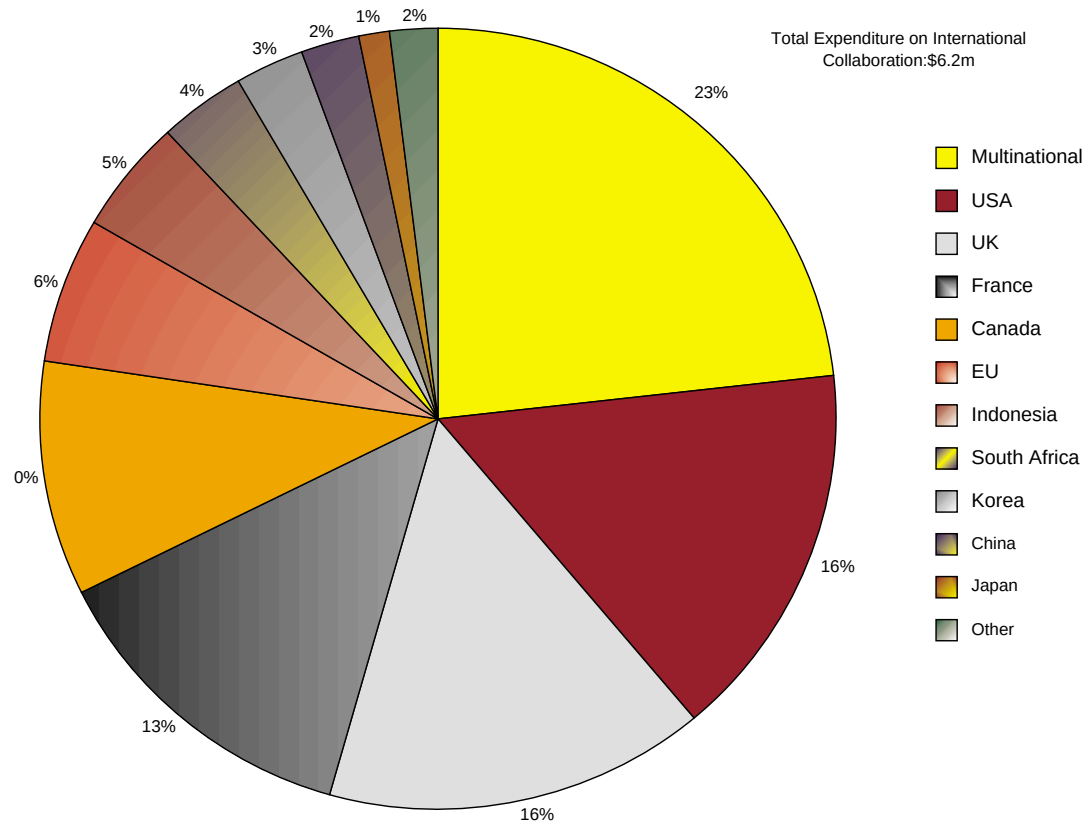
ANSTO - COLLABORATIONS BY COUNTRY



Source: The Allen Consulting Group
Note: **Other**: Asia-Pacific, EU, New Zealand, Philippines, South Africa, Turkey

Figure A60

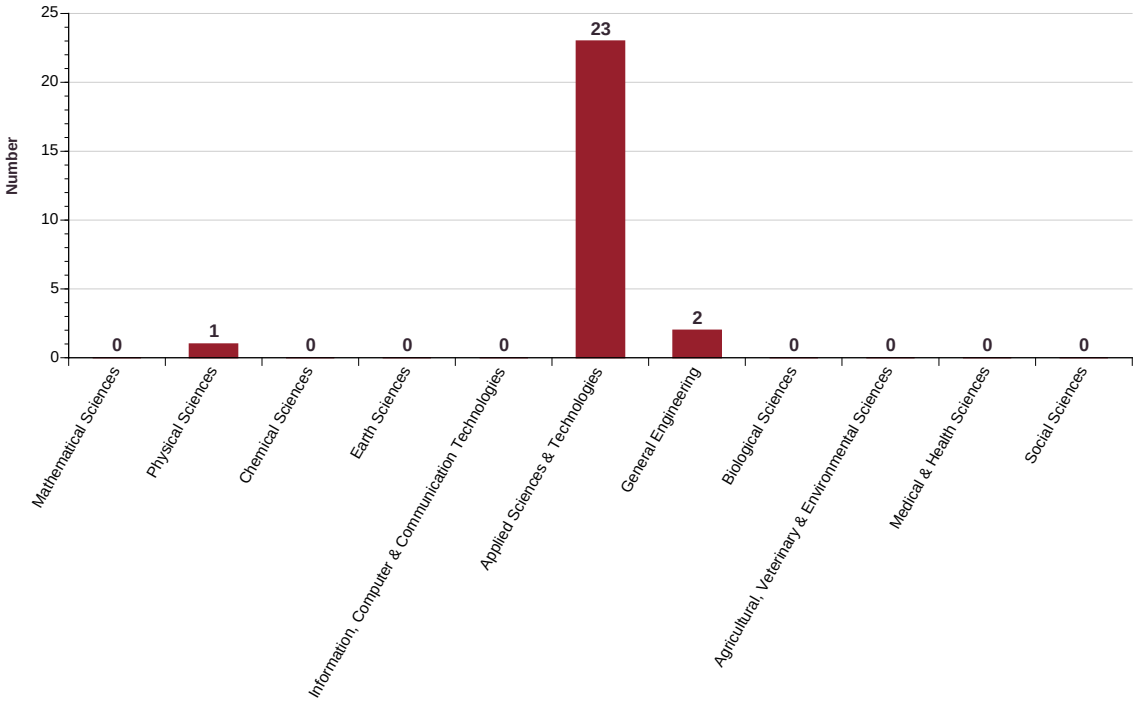
ANSTO - EXPENDITURE BY COUNTRY



Source: The Allen Consulting Group
Note: **Other**: Thailand, Philippines, New Zealand, Asia-Pacific, Turkey

Figure A61

ANSTO - ACTIVITIES BY FIELD OF RESEARCH

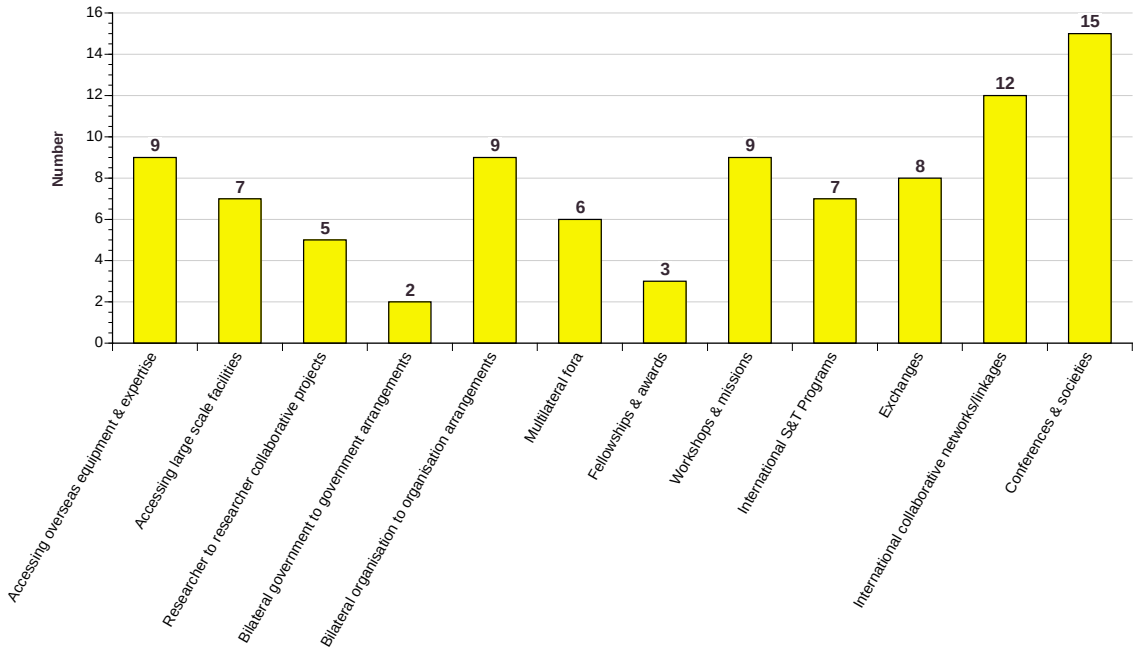


Source: The Allen Consulting Group

The clear majority of projects are in the field of Applied Sciences and Technologies which may well be due to ANSTO's focus upon the safe and secure international implementation of nuclear technology. The purpose and type of activity, shown in Figure A62, illustrates a well-mixed spread of activities across all categories, but with 'conferences & societies' and 'international collaborative networks/linkages' being most common. A figure showing the geographic location of Australian researchers is not provided as all of the 125 researchers are based in metropolitan NSW.

Figure A62

ANSTO - ACTIVITIES BY PURPOSE AND TYPE



Source: The Allen Consulting Group

Like CSIRO, one of ANSTO's major international expenditures is the time spent working on international S&T by its staff. However, we have assumed that this has been reflected in the data that ANSTO has provided.

A11 Australian Institute of Marine Science

The Australian Institute of Marine Science (AIMS) has research facilities in Cape Ferguson, Darwin and Fremantle, and operates two research vessels. Research is undertaken in marine biodiversity and conservation, coastal processes and marine biotechnology. In particular, AIMS has a focus on the ecologically sustainable use of Australia's marine natural resources, where oceans are 'cared for, understood and used wisely for the benefit of all, now and in the future.' As a statutory Authority, AIMS' activities are undertaken in accordance with the Commonwealth's policy framework for the marine environment, which includes *Australia's Ocean Policy* (1988), *Australia's Marine Science and Technology Plan* (1999), the *Review of Marine Research in Tropical Australia* (2001) and the *National Research Priorities* (2002).

A11.1 Analysis

In 2001-2, AIMS estimates that its expenditure on international S&T using Commonwealth funds amounted to $345,385. This figure may include sources of funding other than Commonwealth Government appropriation, such as from ACIAR, DITR and industry, because it is not possible for AIMS to differentiate sources of funding for its collaborative projects.

Collaborations were primarily conducted with Asian and Pacific Island nations where AIMS made in-kind contributions to project and travel costs. AIMS also collaborates with multinational organisations, such as the Global Coral Reef Network (which AIMS coordinates), and the International Coral Reef Network (ICRN, which is primarily Asian focused), where funding is provided from other multinational organisations (such as UNESCO) to cover program costs and AIMS contributes in-kind. AIMS noted that their scientists make a significant effort to maintain S&T networks and that this investment is not tracked or quantified.

A review[63] of AIMS conducted by the Chief Scientist in 2001 stated that, 'In focusing to tropical marine research off the coast of Queensland, the Review was impressed by the degree and effectiveness of collaboration among the organisations located in the region.'

In terms of AIMS' collaborative S&T, the dominant field of research is Biological Sciences, however, research on the marine environment also involves Physical, Chemical, and Earth Sciences. There were four purposes cited for conducting international collaborations: researcher to researcher collaborative projects; workshops and missions; international collaborative networks/linkages; and, conferences and societies. A vast majority of Australian researchers were located in non-metropolitan Queensland at AIMS' main research facilities in Cape Ferguson, near Townsville.

The AIMS 2001-2 annual report contains some additional information on international collaboration. In particular, it is stated that AIMS participated in 110 international collaborations, in 80 'network[s] of collaborating nations,' and that these collaborations took place in 29 different countries.

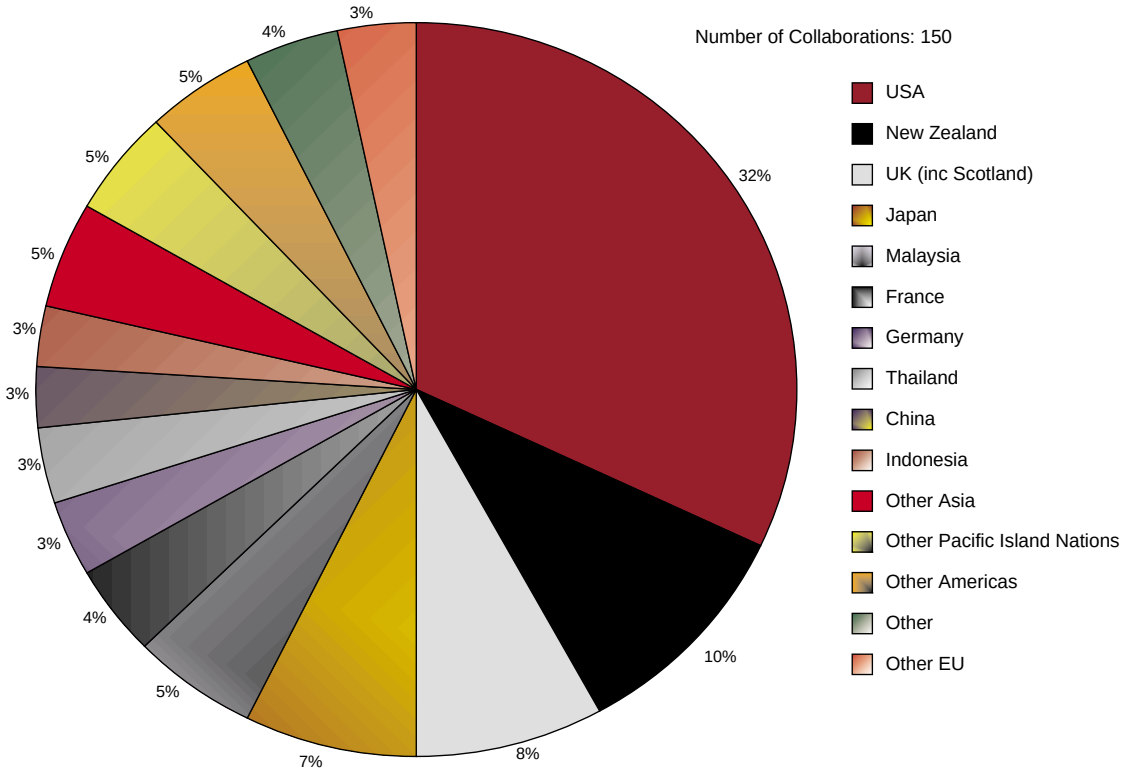
[63] Batterham RJ, 2001, R*eview of Marine Research in Tropical Australia*, p42

These collaborations were listed as contributing to: the reef monitoring network (GCRMN); multi-disciplinary links; National Oceanic and Atmospheric Administration (NOAA), AIMS remote sensing links; and to globally located key centres. We do not know the extent to which Commonwealth sources of funds contributed to these international collaborations. It does appear, however, that international collaboration is a significant component of AIMS' S&T activities.

The latter point is further illustrated in Figure A63, based upon data provided by AIMS for the number of international collaborative projects undertaken by the organisation in 2001-2. Here, it is clear that AIMS collaborates widely, its range including 29 countries, with over a third of collaborations with the US.

Figure A63

AIMS – COLLABORATIONS BY COUNTRY



Source: The Allen Consulting Group

Notes:
1. **Other Asia**: Vietnam, Hong Kong, Korea, Singapore
2. **Other Pacific Island Nations**: PNG, French Polynesia, Guam, New Caledonia, Palau, Solomon Islands
3. **Other Americas**: Brazil, Canada, Mexico, Panama
4. **Other**: Kenya, Israel, Poland, South Africa, Tanzania
5. **Other EU**: Belgium, Italy, The Netherlands, Spain

Appendix B

The Agriculture, Fisheries and Forestry Portfolio

S&T activities are essential when maintaining the international competitiveness and sustainability of Australia's agricultural, forestry, fishing and food industries, as well as access to international markets. In the Agriculture, Fisheries and Forestry Portfolio, agricultural S&T activities are primarily undertaken through the Research and Development Corporations (RDCs). Within the Department of Agriculture, Fisheries and Forestry (DAFF), S&T activities are undertaken by the Australian Bureau of Agriculture and Resource Economics (ABARE), the Bureau of Rural Sciences (BRS), Biosecurity Australia (BA), and the Australian Quarantine and Inspection Service (AQIS).

The Agriculture, Fisheries and Forestry Portfolio supports international S&T where there is an opportunity to progress Australia's agricultural trade interests (eg, supporting international conferences such as the OIV international wine conference[64] held in Adelaide in 2002. The majority of S&T activities undertaken by this portfolio are directed toward domestic issues. The latter is in contrast to ACIAR (see Appendix E) where Australian agricultural S&T is applied internationally. Apart from S&T activities supported by DAFF, agricultural enterprises and researchers may access S&T activities and initiatives (including support for international S&T collaboration), that are administered by other Commonwealth Portfolios and Agencies.

Table B1 summarises the Portfolio's international S&T activities. A total of $7.7m of Commonwealth funds supported such activities, with the majority being allocated through the RDCs (which are analysed and discussed in detail below). International S&T activities were also characterised for DAFF, BA, and the Departmental agencies ABARE and the BRS. An analysis of international S&T activities in AQIS and the Product Integrity Office is not included due to a lack of available data.

Table B1

DAFF PORTFOLIO INTERNATIONAL S&T

Department of Agriculture, Fisheries and Forestry (DAFF) (2002-3)	*Commonwealth Expenditure*	*Commonwealth S&T Expenditure*	*International S&T Expenditure Analysed*
Department			
DAFF	$480m (1)	$46.4m (2)	$163,764
Biosecurity Australia (initiatives relating to flora in 2001-2)	N/A	N/A	$ 69,140
Biosecurity Australia (initiatives relating to fauna in 2002-3)	N/A	N/A	$123,100
Department Agencies			
Australian Bureau of Agricultural and Resource Economics (ABARE)	$9.1m	N/A	$349,296
Bureau of Rural Sciences (BRS)	$8.54m	N/A	$527,666
Department Research Agencies			
Rural R&D Corporations (RDCs)	$21.2m	$154.9m (2)	$6.4m
Total	$498m	$201.3m (2)	$7.7m

Source: The Allen Consulting Group estimates based on data provided by DAFF and the RDCs
Note: 1. DAFF received additional appropriation in 2002-3 primarily for Exceptional Circumstances and Drought Relief, (Source: 2003-04 DAFF Portfolio Budget Statements)
2. Figures for Commonwealth Expenditure on S&T from Minister Nelson's and Minister McGauran's joint press release, May 13, 2003, (see http://www.dest.gov.au/ministers/nelson/budget03/table3.pdf)

B1 The Department of Agriculture, Fisheries and Forestry

The following analysis of the Department of Agriculture, Fisheries and Forestry's (DAFF) international S&T activities includes those performed by DAFF, BA, ABARE and the BRS. The roles of ABARE and the BRS are described in more detail in sections B2 and B3 below.

B1.1 Analysis

The Fisheries Resources Research Fund (FRRF) was established in 1991 with an annual appropriation in the order of $2m and biannual selection period for new projects. This fund is managed by DAFF, with project funds being distributed to DAFF, the Australian Fisheries Management Authority, ABARE and the BRS. Six FRRF projects involved international S&T collaborations in 2002-3 for DAFF, ABARE and the BRS. DAFF was also involved in bilateral and multilateral agreements and initiatives in horticulture and forestry in 2002-3. BA's international activities were primarily conducted in the field of disease control, with six projects for a range of fauna in 2001-2 and two projects relating to detection and standards for plant species in 2002-3. These projects are analysed in Figures B1 to B3 below.

Figure B1 illustrates that over one third of the 27 international collaborations conducted by DAFF and its affiliates were multinational, with a further 29 per cent being conducted in Indonesia, China and Thailand. Expenditure on multilateral collaborations was highest, at 39 per cent (Figure B2), and reflects the fact that most of the international S&T projects were multinational, where a high degree of expenditure was on FAAF multilateral projects. Expenditure on China and the US is primarily related to the 'Water reform options project for the Yellow River Basin', with expenditure of $300,000. Expenditure in PNG is for the BRS project 'Sustainable Management for PNG Forestry' (discussed below).

All but two projects were characterised by field of research as 'agricultural, veterinary and environmental sciences' (and hence, no figure of this result has been provided here). Figure B3 illustrates the purpose and type of DAFF's activities, with 'international collaborative networks/linkages' and the two types of bilateral arrangements being the most common.

Figure B3 reflects the nature of DAFF's international S&T, namely that it is focused upon involvement in international fora and developing access to international markets for Australian rural industries. This is unlike other agencies where international S&T is more research-driven, with 'access to overseas equipment and expertise' a primary purpose (see Figure B6, which demonstrates this point for the RDCs).

It is not possible to comment on the geographic location of researchers, as this information was not available.

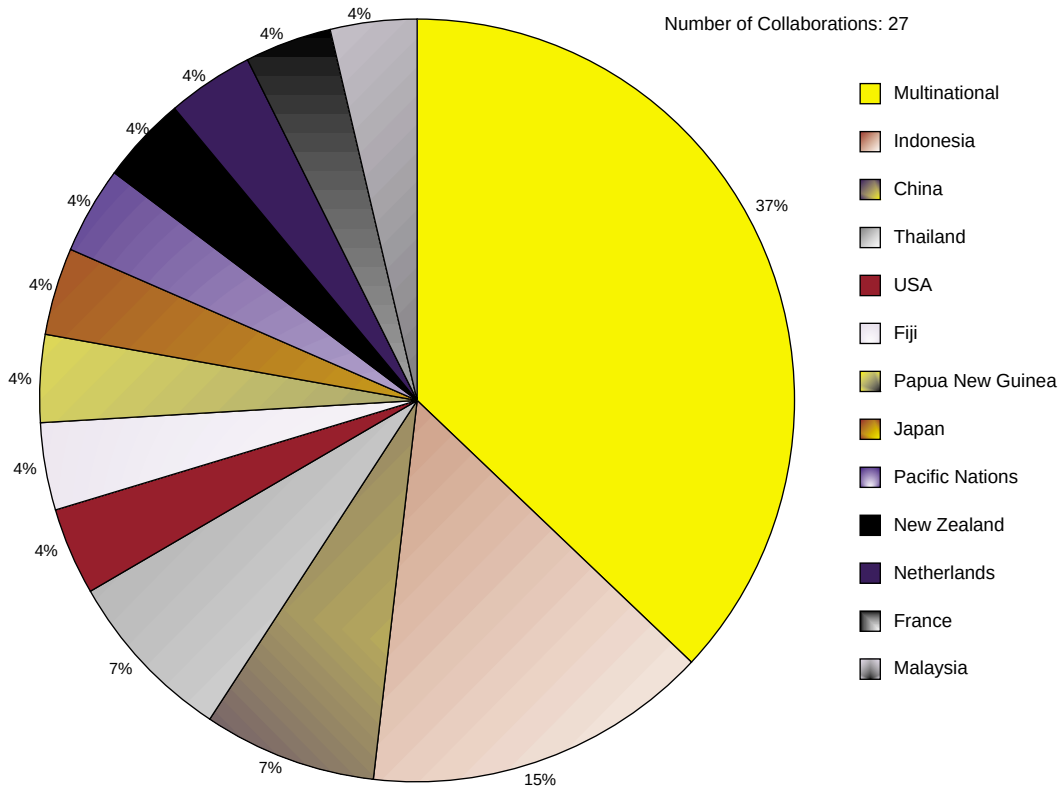
[64] Office International de la Vigne et du Vin

B2 Australian Bureau of Agriculture and Resource Economics

The Australian Bureau of Agriculture and Resource Economics (ABARE) is a research bureau that provides economic policy analysis and forecasts. Its research aims to enhance the competitiveness of Australia's agricultural and resource industries, as well as the quality of the Australian environment. It is a separate entity though does operate under the direction of DAFF. ABARE provides a forecasting service for commodities and an overall economic forecast using its Global Trade and Environmental Model (GTEM). In a similar way to the CSIRO, ABARE provides a number of services under contract to the private sector as well.

Figure B1

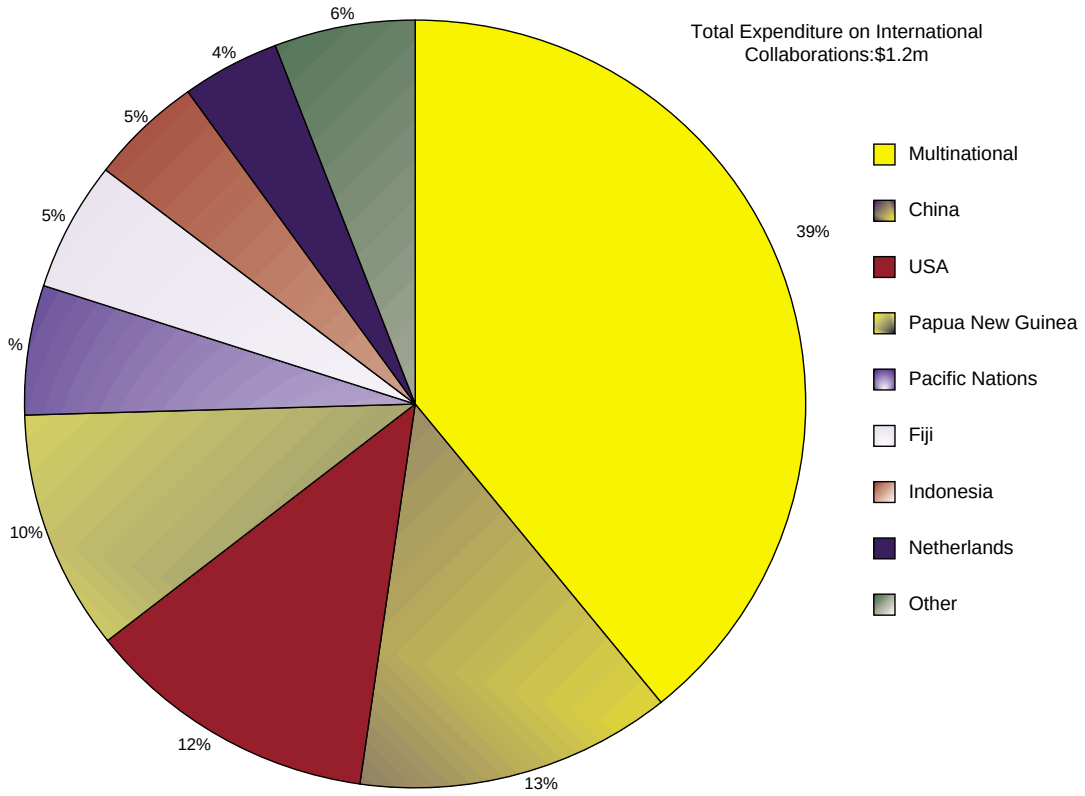
DAFF, BA, ABARE & BRS – COLLABORATIONS BY COUNTRY



Source: The Allen Consulting Group estimates based on data provided by DAFF.

Figure B2

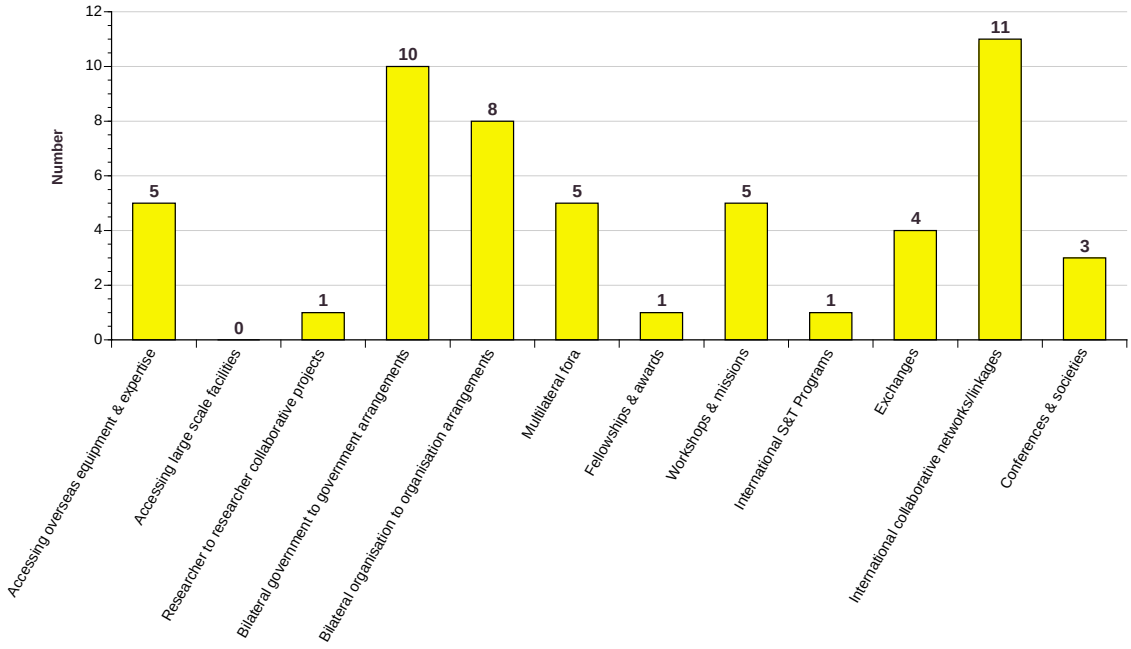
DAFF, BA, ABARE & BRS – EXPENDITURE BY COUNTRY



Source: The Allen Consulting Group estimates based on data provided by DAFF
Note: **Other**: Thailand, Malaysia, New Zealand, France, Japan

Figure B3

DAFF, BA, ABARE & BRS – ACTIVITES BY PURPOSE AND TYPE



Source: The Allen Consulting Group estimates based on data provided by DAFF

In building GTEM, ABARE has developed significant general equilibrium modelling capacity suitable for analysing international policies with wide-ranging economic impacts, such as climate change, agricultural trade reform and other trade issues. ABARE provides the model and its databases to a number of overseas agencies that are interested in undertaking research in these areas, and also conducts training courses in the use of GTEM. In 2002-3 ABARE undertook initial GTEM training for a group of Thai academics and government officials with a view to transferring GTEM next year.

ABARE also conducted follow up training on recent GTEM developments with a team from the National Tsing Hua University in Taiwan who have been using GTEM since 1999. In 2002-3 the cost for the Thai training was $77,500, funded by DAFF, and the cost of the Taiwanese training was $12,500, funded by Taiwan. Other projects involving international S&T in 2002-3 were part of the Fisheries Resources Research Fund.

B3 Bureau of Rural Sciences

The Bureau of Rural Sciences (BRS) is not a research agency but, instead, is a provider of science analysis for the development of government policy. At the interface between science and policy, the BRS is an essential part of the Government's capacity for integrated, evidence-based policy development. It provides scientific advice to Government on: developing profitable, competitive and sustainable, agricultural, food, fisheries and forestry industries; and on enhancing the natural resource base, to achieve greater national wealth, and stronger rural and regional communities.

On international fisheries, BRS spent approximately $300,000 in 2001-2 participating in regional fisheries fora and outcomes that ensure the sustainable development of Australia's pelagic and deep-sea fisheries; particularly on migratory fish stocks (i.e. shared internationally) such as southern bluefin tuna. BRS scientists have represented Australia and played a leading scientific role for DAFF in forums such as the Commission for the Conservation of Southern Bluefin Tuna, Indian Ocean Tuna Commission and the Western and Central Pacific Fisheries Commission.

In 2002-3 BRS fisheries expenditure on S&T was higher than the previous year, at approximately $403,000. This estimate accounts for significant input to the 4th preparatory conference for the Western and Central Pacific Fisheries Convention (in Fiji) as well as funding for providing data under the United Nations Fish Stocks Agreement.

In forestry, BRS has undertaken some work in and for Papua New Guinea developing their capacity for forestry management. This work, titled ‘Planning methods for sustainable management of timber stocks in Papua New Guinea's forests’, has been funded by ACIAR, with a total expenditure of $374,000 over several years, starting in 2001-02 at $242,479. A third of this expenditure has been allocated to the BRS for 2002-3.

BRS also participates in biodiversity conventions and various other international and regional fora.

B4 Research and Development Corporations

The main role of the Research and Development Corporations (RDCs) is to assist their respective industries in accessing, understanding and implementing leading edge technologies. The RDCs in the Agriculture, Fisheries and Forestry Portfolio spend approximately $390m on R&D, with a goal of ensuring that Australia's rural industries have access to the technologies critical for international competitiveness.[65]

There are 14 rural R&D organisations in the Agriculture, Fisheries and Forestry Portfolio, including nine statutory corporations covering cotton, dairy, fisheries, forest and wood products, grains, grape and wine, land and water, rural industries and sugar. Eggs, horticulture, port, meat and livestock and wool are covered by similar corporate arrangements.

Expenditures are financed by a combination of industry levies and Commonwealth contributions. Although there are some exceptions, it is generally the case that individual RDC expenditures on R&D from levy-derived funds are matched dollar-for-dollar by Commonwealth contributions.

B4.1 Analysis

Table B2 shows the expenditure on total R&D by the RDCs as well as the estimated Commonwealth share of expenditures. Revenue for each RDC is based on Commonwealth matching, however, in some cases industry levies and other industry support exceeds the Commonwealth share. On average, the Commonwealth share is 50 per cent of total expenditure.

For this analysis, the relevant share of Commonwealth funds for each RDC has been applied. The RDCs provided information on a project-by-project basis for all international collaborations. In most cases, these were classified as being exclusively international in nature but where they were not, each RDC provided their own estimate of the international share.

Total international S&T expenditures for all RDCs are estimated to be $6.4m in 2001-2, representing 4 per cent of total Commonwealth expenditures by the RDCs. This varies for each RDC — with Meat and Livestock Australia ranking highest with 11 per cent of total expenditure going to international S&T. The Grains Research and Development Corporation (GRDC) and Australian Wool Innovation (AWI) rank second with shares of 4 per cent of total expenditure.

[65] Rural R&D Corporations and Companies, Annual Report. 2001-02.

Table B2

AGENCY INVOLVEMENT IN INTERNATIONAL S&T

R&D Corporation (2001-2)	*Total Expenditure ($ '000)*	*Commonwealth Expenditure ($ '000)*	*International S&T Expenditure Commonwealth Share ($ '000)*
Forest and Wood Products Research & Development Corporation (FWPRDC)	8,000	3,300	26
Cotton Research & Development Corporation (CRDC)	14,600	7,200	65
Dairy Research & Development Corporation (DRDC) (2)	31,900	15,400	171
Fisheries Research & Development Corporation (FRDC)	23,000	15,800	574
Grains Research & Development Corporation (GRDC)	113,800	40,800	1,714
Grape and Wine Research & Development Corporation (GWRDC)	12,200	5,800	31
Horticulture Australia Limited	45,200	26,200	710
Meat and Livestock Australia (M&LA)	45,700	22,900	2,500
Australian Pork Limited	7,400	3,700	1
Australian Wool Innovation Limited (AWI)	31,800	14,400	647
TOTAL	333,600	155,500	6,439

Source: The Allen Consulting Group and RIRDC *The Rural R&D Corporation Framework* (unpublished). Columns may not add to total due to rounding.

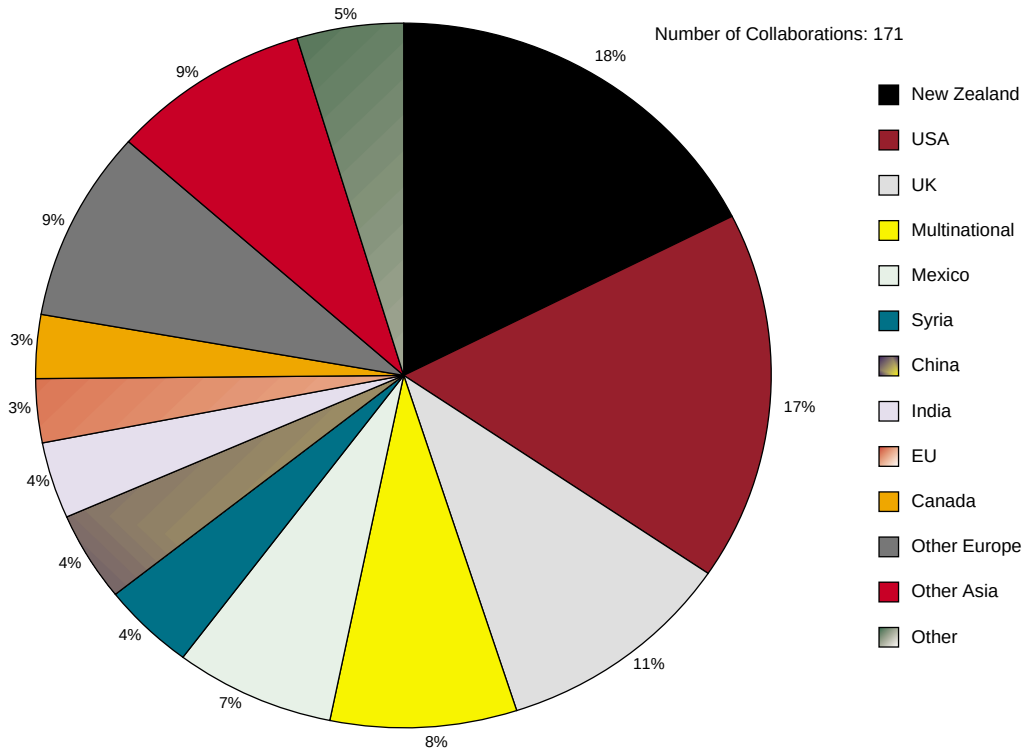
Notes:
1. Other RDCs not included in this table did not report on international activities, presumably because such activities are minimal, for example, Land and Water Australia.
2. The DRDC has recently merged with the Australian Dairy Corporation to form Dairy Australia. All statutory responsibility for DRDC has been transferred to Dairy Australia from July 1 2003.

Figures B4 to B7 summarise the characteristics of the international S&T activities of the RDCs. Figure B4, illustrates the distribution of 171 collaborations identified for the RDCs, 83 of which are with the GDRC. Australia's major partner is New Zealand where there are significant collaborations for wool, horticulture, fisheries, dairy and meat and livestock. The US is also a major partner, particularly in relation to grape and wine, cotton, horticulture, grains and to some extent for meat and livestock (where 'Northern America' was cited as a major collaborative partner). Expenditure on collaboration is clearly concentrated — 42 per cent of total expenditure was invested in collaborations with New Zealand and another 37 per cent distributed among five areas, Mexico, North America, Other EU, US and the UK (see Figure B5).

The majority of RDC collaborations were in the field of Agricultural, Veterinary and Environmental Sciences (therefore, a figure showing field of research has not been provided here). A much smaller share of collaborations were in Biological Sciences, and collaborations with AWI were predominantly in Applied Sciences and Technologies.

Figure B4

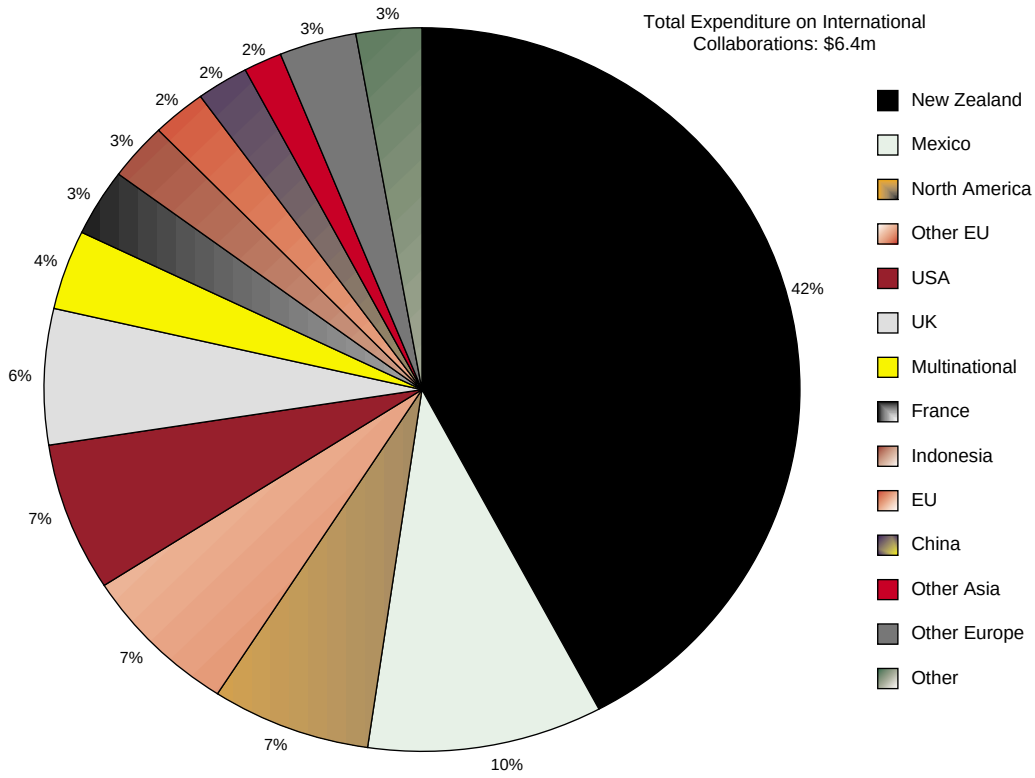
RURAL DEVELOPMENT CORPORATIONS – COLLABORATIONS BY COUNTRY/ECONOMY



Source: The Allen Consulting Group estimates based on Personal Communication and information provided by the RDCs
Notes: 1. **Other Europe**: Germany, France, Russia, Other EU, Turkey, Poland, Belgium, Czech Republic
2. **Other Asia**: Indonesia, Asia, West Asia, East Asia, Taiwan, SE Asia, Pakistan, Japan
3. **Other**: South Africa, North Africa, North America, Sub Antarctic

Figure B5

RURAL DEVELOPMENT CORPORATIONS – EXPENDITURE BY COUNTRY/ECONOMY

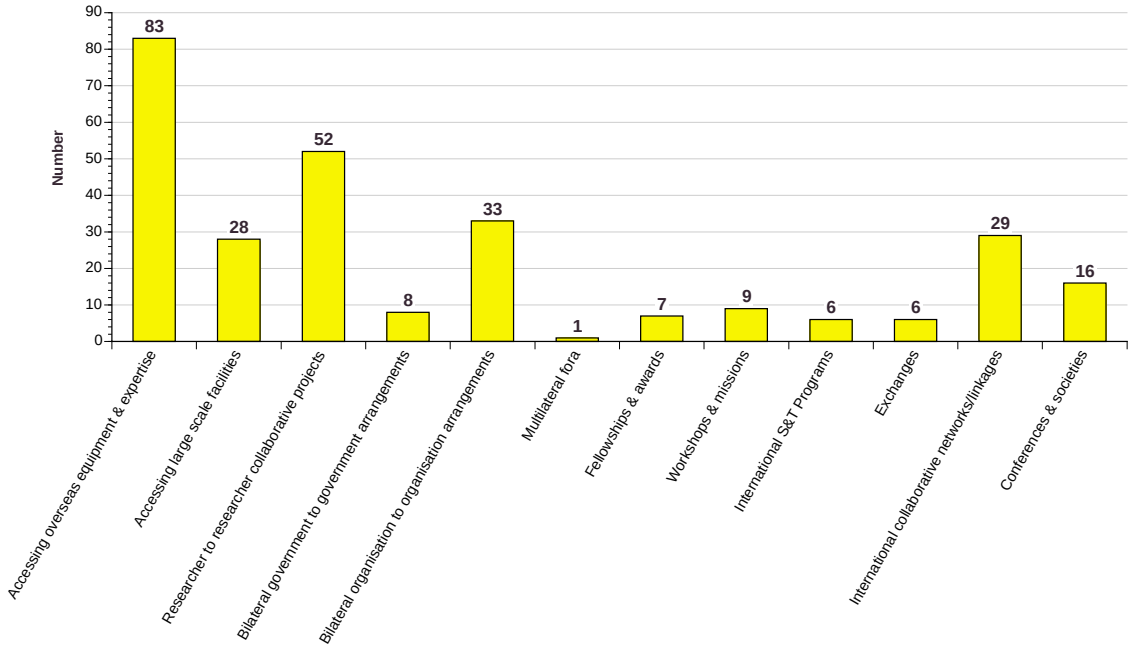


Source: The Allen Consulting Group estimates based on Personal Communication and information provided by the RDCs.
Notes: 1. **Other Asia**: Asia, India, East Asia, SE Asia, Pakistan, Japan, Taiwan
2. **Other Europe**: Germany, Belgium, Poland, Russia, Czech Republic, Turkey
3. **Other**: Syria, Canada, Sub Antarctic, South Africa, North Africa

Figure B6 indicates that the main purpose for collaboration was to access overseas equipment and expertise while researcher-to-researcher collaborations ranked second. As discussed earlier, this finding contrasts strongly with the same analysis of DAFF (see Figure B3). A total of 278 activities were identified ranging across all 12 types of collaboration listed. This figure understates the range and number of collaborations, however, since horticulture and meat and livestock figures are not available.

Figure B6

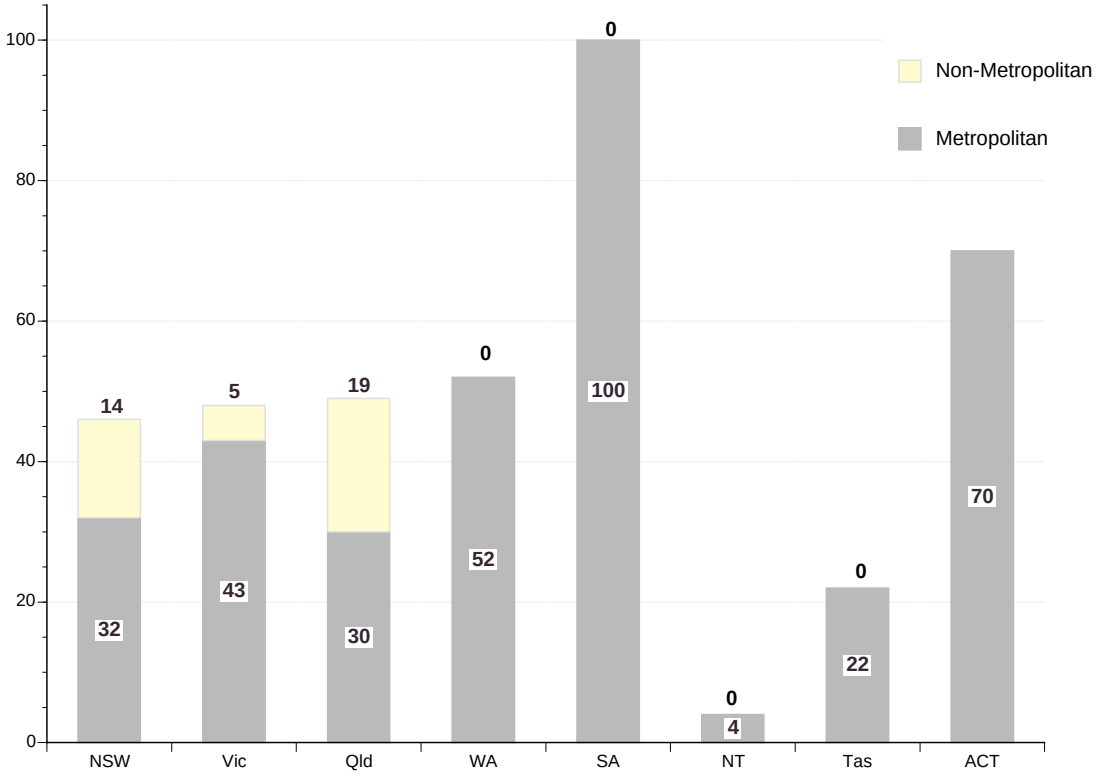
RURAL DEVELOPMENT CORPORATIONS – ACTIVITIES BY PURPOSE AND TYPE



Source: The Allen Consulting Group estimates based on Personal Communication and data provided by the RDCs.

Figure B7

RURAL DEVELOPMENT CORPORATIONS – RESEARCHERS BY LOCATION



Source: The Allen Consulting Group estimates based on Personal Communication and data provided by the RDCs.

Figure B7 shows that researchers were distributed across Australia with concentrations in Adelaide and the ACT. It is probable that number and distribution of non-metropolitan researchers is underestimated, as these researchers were not easy to identify once their funded project had finished. Further, Horticulture Australia, AWI and Meat and Livestock Australia were unable to provide data on the geographic location of researchers, and it is not known how these data would affect the distributions shown in Figure B7.

B4.2 Individual RDC Analysis

The overall summary of international collaborations is dominated by the activities of the GRDC. This is because the GRDC provided a comprehensive characterisation of its international collaborations. Details of the GRDC are provided below followed by some examples of international collaborations undertaken by other RDCs.

Grains Research and Development Corporation (GRDC)

The GRDC is a world leader in developing and applying molecular markers in wheat and barley breeding programs. The GRDC estimates expenditure on international S&T at $14.3m in 2001-2, of which the Commonwealth funded $1.7m.

Out of all the RDCs characterised the GRDC received the highest amount of Commonwealth funds in 2001-2. In terms of international expenditure on S&T, Meat and Livestock Australia ranked first at 39 per cent, and the GRDC second, at 26 per cent, out of the characterised RDCs. The interest in international collaborations on behalf of the meat and livestock, and grains industries appears to reflect their export orientation and the access to overseas expertise.

Figures B8 and B9 show the estimated distribution of international S&T activities undertaken by the GRDC in 2001-2. In contrast to the total for all RDCs (Figures B4 and B5) the main GRDC partner is Mexico.

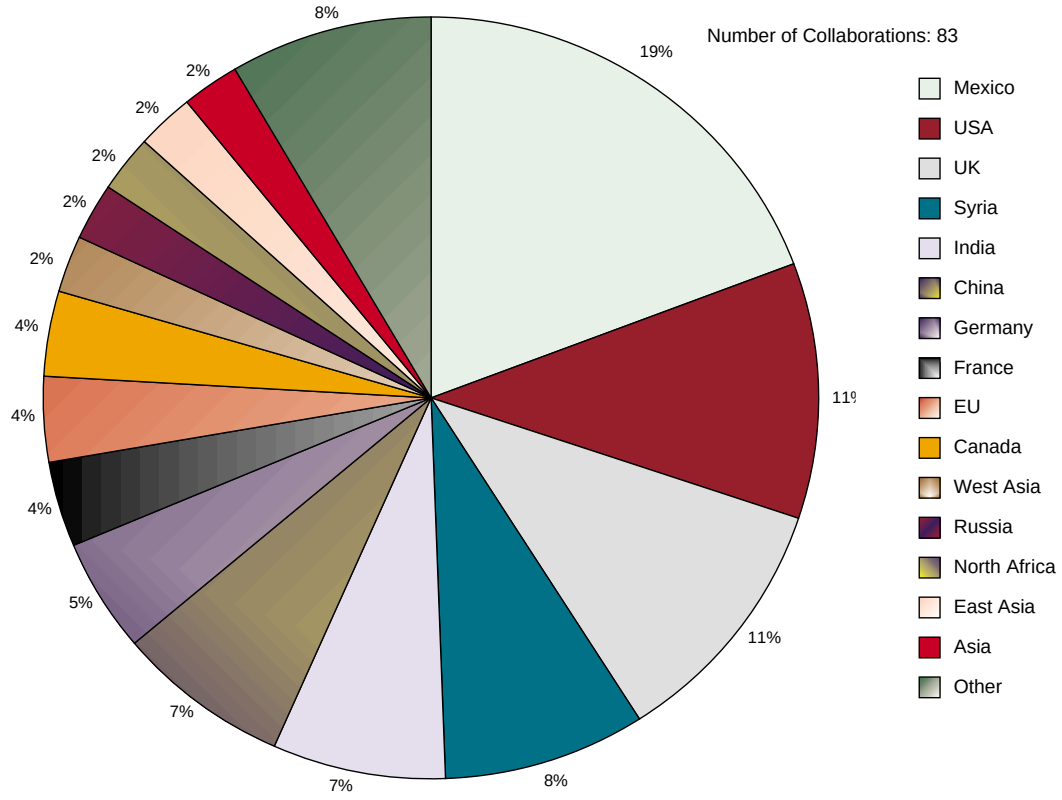
In keeping with the overall trend across all RDCs, the majority of GRDC collaborations were identified as Agricultural, Veterinary and Environmental Sciences, with a smaller share identified as Biological Sciences.

Figure B10 shows a distribution of S&T activities by purpose and type for the GRDC that is similar to the pattern for all RDCs (see Figure B6), with concentrations on 'accessing overseas equipment and expertise', 'accessing large-scale facilities' and 'researcher-to-researcher collaborative activities'. The overall RDC pattern of activities is dominated by the GRDC. It should therefore be noted that the GRDC named more purposes for individual research projects, and noted bilateral-organisation-to-organisation purposes more often than other RDCs.

Geographical distribution of Australian researchers in Figure B11 shows that the majority of GRDC researchers were concentrated in Adelaide and the ACT, with other researchers spread across other state capitals. Once again, these estimates dominate the results for all RDCs. One reason for this may be the GRDC's reporting of an unusually large number of researchers for some projects. For example, project 'GRD 86' has 41 people in ACT, and 'GRDC 102' has 25 people in SA. It may be that these projects are labour intensive, or alternately, that the GRDC has better data for researchers by location. These projects may also involve participatory research by farmers, which is a key component of a number of GRDC funded projects, particularly those focused on farming systems research.

Figure B8

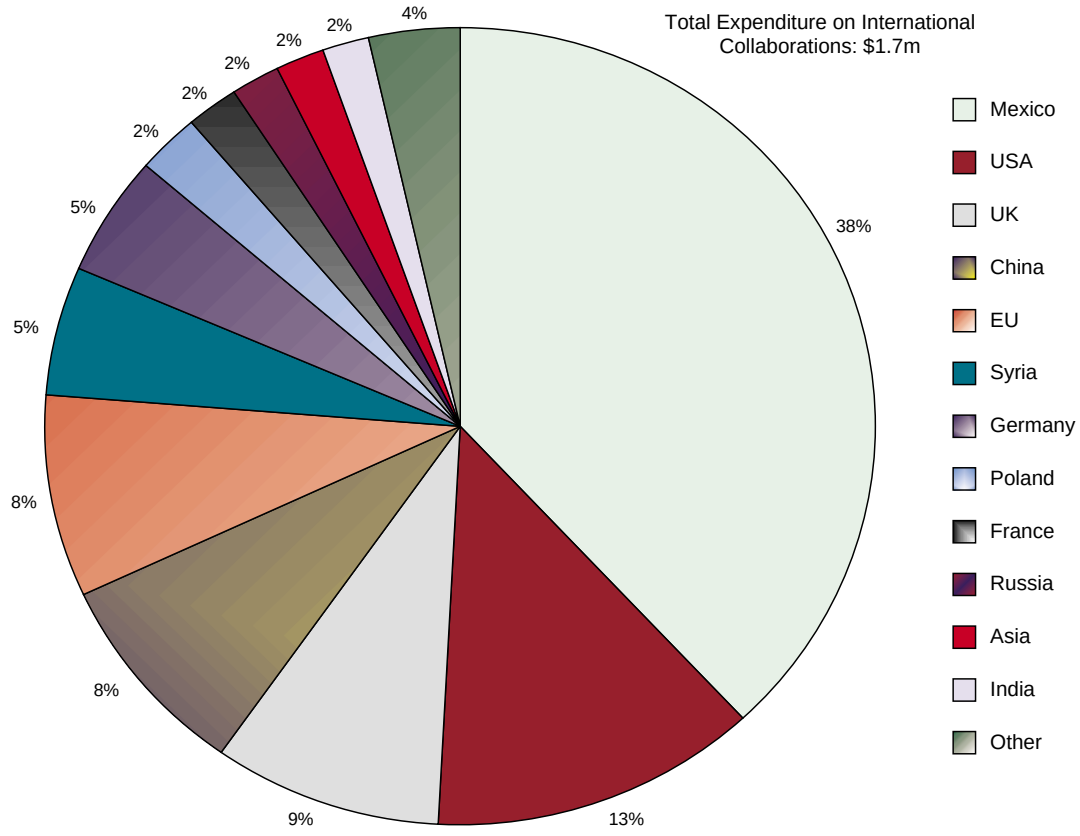
GRDC – INTERNATIONAL COLLABORATIONS BY COUNTRY/ECONOMY



Source: The Allen Consulting Group estimates based on data provided by the GRDC.
Note: **Other**: Turkey, Taiwan, South Africa, SE Asia, Poland, Pakistan and Indonesia

Figure B9

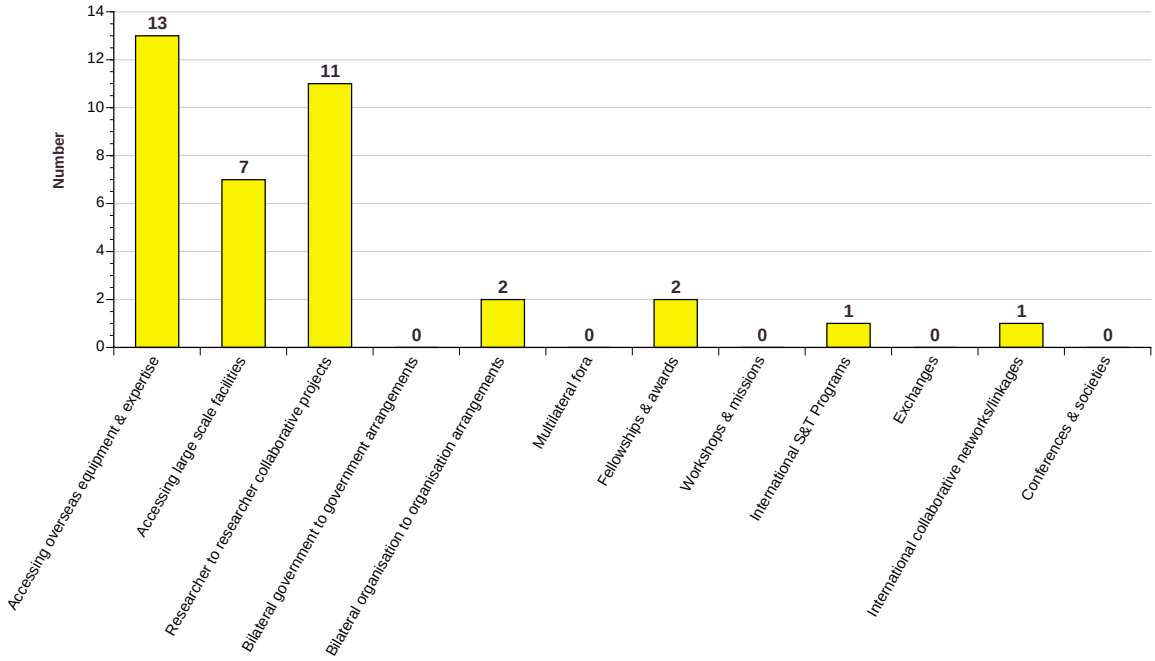
GRDC - EXPENDITURE BY COUNTRY/ECONOMY



Source: The Allen Consulting Group based on data provided by the GRDC
Note: **Other**: Canada, East Asia, South-East Asia, West Asia, North Africa, Pakistan, Taiwan, Indonesia, South Africa, Turkey

Figure B10

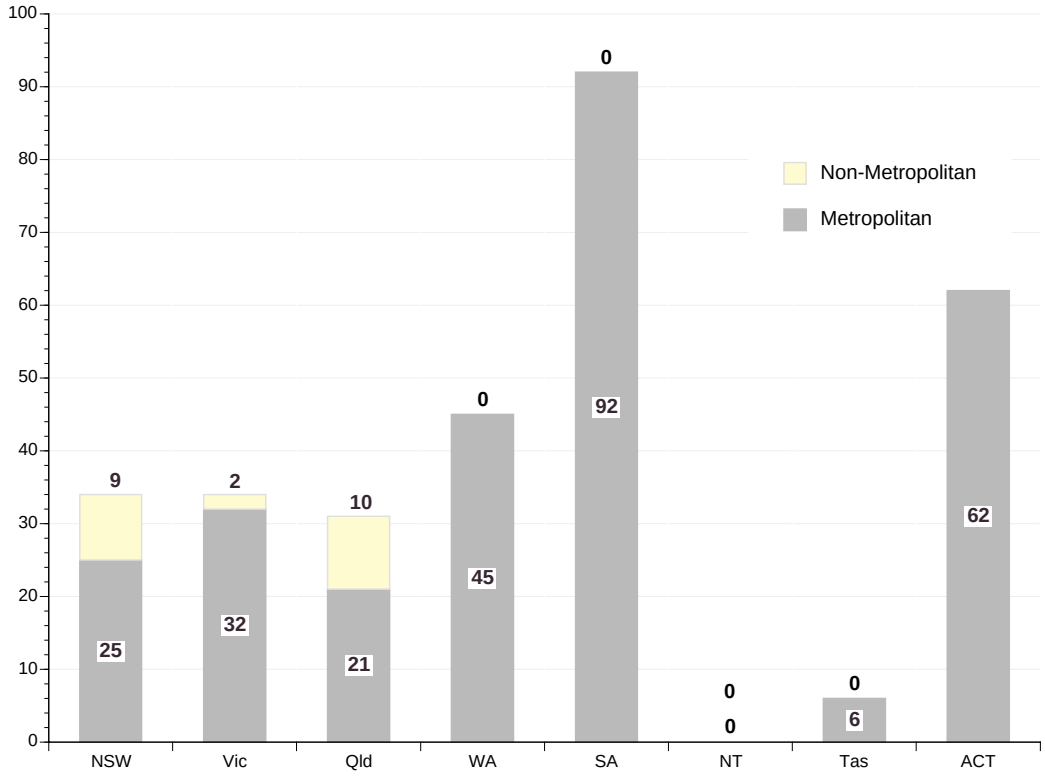
GRDC - ACTIVITIES BY PURPOSE AND TYPE



Source: The Allen Consulting Group estimates based on data provided by the GRDC.

Figure B11

GRDC – RESEARCHERS BY LOCATION



Source: The Allen Consulting Group estimates based on data provided by the GRDC.

Other RDCs

The overall summary of RDC S&T collaborations and expenditures (see Figures B4 & B5) reflects a number of international collaborations that further the research and market development needs of the individual RDCs. RDCs other than the GRDC indicated a relatively higher number of collaborations through conferences and exchanges. Examples of collaborative activities undertaken by these RDCs include the following.

- AWI international collaboration reflects ties with the international research community and also its dependence on export markets. For example, $16,000 was provided for a design award in the UK established to promote innovative developments in the use of wool fibre. This RDC is also unusual due to the applied nature of its international research projects, the majority being in Applied Sciences and Technologies, rather than Agricultural, Veterinary and Environmental Sciences. Thus, it appears that the majority of international S&T expenditure was geared to promoting innovative changes to how wool is used. The main partners are in the UK and New Zealand.

- The Forest and Wood Products Research and Development Corporation estimates that it spent a total of $10,000 on international conferences and $50,000 on Fellowships in 2001-2. The Commonwealth financed approximately 43 per cent of this, or $26,000.

- The Cotton Research and Development Corporation's emphasis has been in supporting CSIRO Plant Industry researchers in biotech research into healthier forms of cottonseed oil that are more competitive with sunflower and canola oils. The CRDC estimates that $65,000 of its total R&D expenditure of $14.6m, was directed at international S&T collaborations of all types. These mainly involved attendance at overseas conferences, group study tours to the US and South Africa, and financing of overseas researchers from the US and UK to come to Australia and review Australian activities.

Appendix C

Health and Ageing Portfolio

The Health and Ageing Portfolio is comprised of the Department of Health and Ageing and a number of agencies.[66] Services under the Portfolio are provided for the aged, including carers; public health and medical research; health promotion and disease prevention; primary health care of Aboriginal and Torres Strait Islander people; pharmaceutical benefits; health benefits schemes; specific health services, including human quarantine; national drug abuse strategy; regulation of therapeutic goods; notification and assessment of industrial chemicals; and, gene technology regulation.

Of most relevance to S&T outcomes is the Portfolio's 'Outcome 9' that aims to increase knowledge, information and training to improve the health of Australians. The focus is on improving health and medical workforce planning, working with the community in health care planning and delivery, strategic investment in high impact health and medical research, leading a national strategic approach to more effective information management and providing a leadership role in improving health outcomes in Australia. [67]

Within the Portfolio the following divisions and groups are responsible for achieving Outcome 9: Health Services Improvement Division; Information and Communications Division; National Health and Medical Research Council; Portfolio Strategies Division; and the Australian Institute of Health and Welfare.

Most groups support domestic programs while the major source of support for international scientific collaborative activities in this Portfolio is through the National Health and Medical Research Council (NHMRC). For this reason, information collation has been focused on estimating international collaborations supported by NHMRC programs and expenditures. NHMRC expenditures are summarised in Table C1.

C1 The National Health and Medical Research Council

The National Health and Medical Research Council (NHMRC) is a statutory body within the Health and Ageing portfolio responsible for supporting health and medical research excellence. Based on the information provided by the NHMRC, it is estimated that 10 per cent, or $26.9m of the total expenditure $267.3m is the expenditure on international S&T collaborations by the NHMRC through its grant programs (Table C1). This table does not cover all grant expenditures by the NHMRC. Included here are grant programs where NHMRC staff indicated that there are likely to be international collaborations.

[66] Agencies in this portfolio include the Health Insurance Commission, the Aged Care Standards and Accreditation Agency, the Private Health Insurance Administration Agency, Australian Hearing Services, the Private Health Insurance Ombudsman, the Australia New Zealand Food Standards Authority, the Australian Institute of Health and Welfare and the National Health and Medical Research Council.

[67] http://www.health.gov.au/budget2003/pdf/bportfoliooverview.pdf

Table C1

NHMRC — PROGRAMS SUPPORTING INTERNATIONAL S&T

Activity Analysed - 2002 Grant Year Expenditures	*Commonwealth S&T Expenditure Analysed (1) ($millions)*	*International S&T Expenditure Analysed ($millions)*
Department of Health and Ageing		
Other International Activities	***N/A(3)***	***N/A(3)***
National Health & Medical Research Council		
Grants		
Project	145.984	15.992
Program	62.453	0.835
Australian-European Collaborative Grants	0.057	0.057
Fellowships	40.380	-
MHF&S(2)	7.025	7.025
Industry	0.840	0.080
INSERM	0.298	0.298
Scholarships	7.870	-
Travelling Grant	0.842	0.122
SRDC	4.949	0.315
Career Development	2.008	0
Commonwealth Aids Research Grants (CARG)	0.858	0
NHMRC Burnet Award	0.734	0.734
Capacity	0.459	0
Total Grants	265.691	25.336
Support for Other International Activities		
GBIF	0.042	0.042
HUGO	0.050	0.050
Celera	1.500	1.500
Total	267.283	26.928

Source: NHMRC and The Allen Consulting Group

Notes:
1. NHMRC expenditures listed here are those identified by the NHMRC as the ones with an international S&T component. Definitions and descriptions of grant programs are provided in the text.
2. MHF&S refers to the C.J. Martin, Neil Hamilton Fairly, Howard Florey Centenary and Sidney Sax Fellowships collectively.
3. N/A: Not Available.

The 10 per cent estimate is based on analysis of the grant program information provided by the NHMRC. It should be noted, however, that in the broadest sense, it might be argued that *all* medical research requires international collaboration. However, grant criteria do not include international collaborations specifically, and therefore, these collaborations are not tracked for individual grants. Hence, the information is not available to fully analyse all cases of international collaborations. A goal for future analysis would be to evaluate the international collaborations that may be associated with other programs such as the *Tall Girls* project and the *Twins Register*.

Where possible, NHMRC grant details have been analysed, and the explicit descriptions of international collaborations and the collaborators involved have been identified, on a grant-by-grant basis. The process adopted in each case is described below, along with a short description of the grant and the characteristics of its international collaborations. In the next section, NHMRC policy regarding international collaborations is summarised as background to the analysis of international collaborations that are funded.

C2 Overview of Policy

In its December 2002 publication *Review of the Implementation of the National Health and Medical Research Council's Strategic Plan 2000-2003*, the NHMRC provides a description of its current objectives as a medical research funding organisation. In general, the focus is on building a world-class domestic medical research base with the ultimate goal of improving the health of Australians now and in the future. Specific encouragement of international collaborations is not stated to be central to the current goals. Where international collaborations are noted, the discussion revolves around how these collaborations position Australia as a world-class research country and that support of international partnerships and collaborations should be increased in the future. This is stated in the context of aligning its goals with the overarching National Research Priorities.

The emphasis on international collaborations is consistent with the recommendations of the 1998 Health and Medical Research Strategic Review, which was commissioned to make a comprehensive review into the state of Australian health and medical research. The report, entitled *The Virtuous Cycle - Working together for health and medical research (The 'Wills Review')*, included 56 far-reaching recommendations that were referred to the NHMRC for action.[68] Since the Review, the NHMRC states in its Budget documents that it has made many changes to the way it fulfils its role as the nation's peak supporter of health and medical research. Specific areas of activity include evaluating the outcomes of research, reshaping the research funding system and grant assessment procedures, building the capacity to conduct world class research, developing a framework for identifying research priorities, translating the results of research into policy and practice, improving the system of health ethics review, increasing involvement of consumers, fostering technology transfer and the commercialisation of research and, most importantly for this study, expanding international collaboration.

One example of a new grant made in support of increasing international collaborations is the Burnet Award, which was set up so that Australians who have established themselves overseas as pre-eminent researchers can be attracted back to help position Australia as a world leader in medical research. In addition, there is a discussion included in *Review of the Implementation of the National Health and Medical Research Council's Strategic Plan 2000-2003,* of protecting international property rights for new discoveries and encouraging Australian researchers to develop their research discoveries here. Throughout the document there are references to encouraging Australian researchers to remain based in Australia while gaining some international experience. Specific programs to support this goal are discussed in Section C1.3.

[68] http://www.health.gov.au/nhmrc/wills/hmrsr/discuss.pdf

C3 International Collaborations

The NHMRC is involved in international S&T collaborations in two ways. On a corporate level, the NHMRC participates in a number of international health collaborations. As a granting body, the NHMRC funds research that involves international collaborations.

The NHMRC notes its international collaborations on a corporate level with a number of examples. These include ongoing support of effective health research systems in developing countries. Further examples include the following activities.

- The NHMRC participated in World Health Organisation (WHO) initiatives including the Bangkok consultation to discuss health research systems in developing countries in Australia's region and participation in the Global Forum for Health Research in Geneva.
- As of October 2003, the International Collaborative Research Grants Scheme will support research to improve health and health research capacity in developing countries. This is a major project set up in collaboration with the Health Research Council of New Zealand. The Wellcome Trust will match some £6m (approx $A14.8m) from the two countries over five years.
- The joint Juvenile Diabetes Research Foundation (JDRF) with the NHMRC has been supporting collaborations on diabetes research attracting $7m offshore funding in the past. No projects were funded in 2002.
- The Australian Health Ethics Committee (AHEC) participates in international meetings to exchange information and assess global views on a range of ethical matters. In 2002 AHEC participated in the bi-annual Global Summit of National Bioethics Commissions in Brazil. Delegations are hosted here as well, for example, Australia is hosting the 2004 Global Summit of National Bioethics Commissions.
- The NHMRC has formed partnerships with the Health Research Council of New Zealand and the Canadian Institutes of Health Research to advance Indigenous health research.
- The Australia-EU collaborative grants program provides funding to assist Australian participation in projects selected for funding under the European Commission's Sixth Framework Programme. The NHMRC indicates that under this agreement, an annual amount of $600,000 is allocated for this program over three years. In 2002, NHMRC expenditure was $57,190 for two projects. Both projects are in public health with one project based at the University of Queensland and the other at Flinders University. The agreement governing this grant program represents 48 collaborating EU groups.
- The NHMRC provided detailed information for its grants in 2002 from which we were able to extract information about the grant programs that have at least some international collaboration involved. As indicated in Table C1, the NHMRC total expenditure on grants in 2002 was $267.3m. Our analysis indicates that 10 per cent of this expenditure, at $26.9m, is the amount spent on international collaborations. As noted previously, with more detailed data, it would be ideal to be able to evaluate any international collaborations that may be undertaken as part of other funded projects such as the Tall Girls and Twins Register.

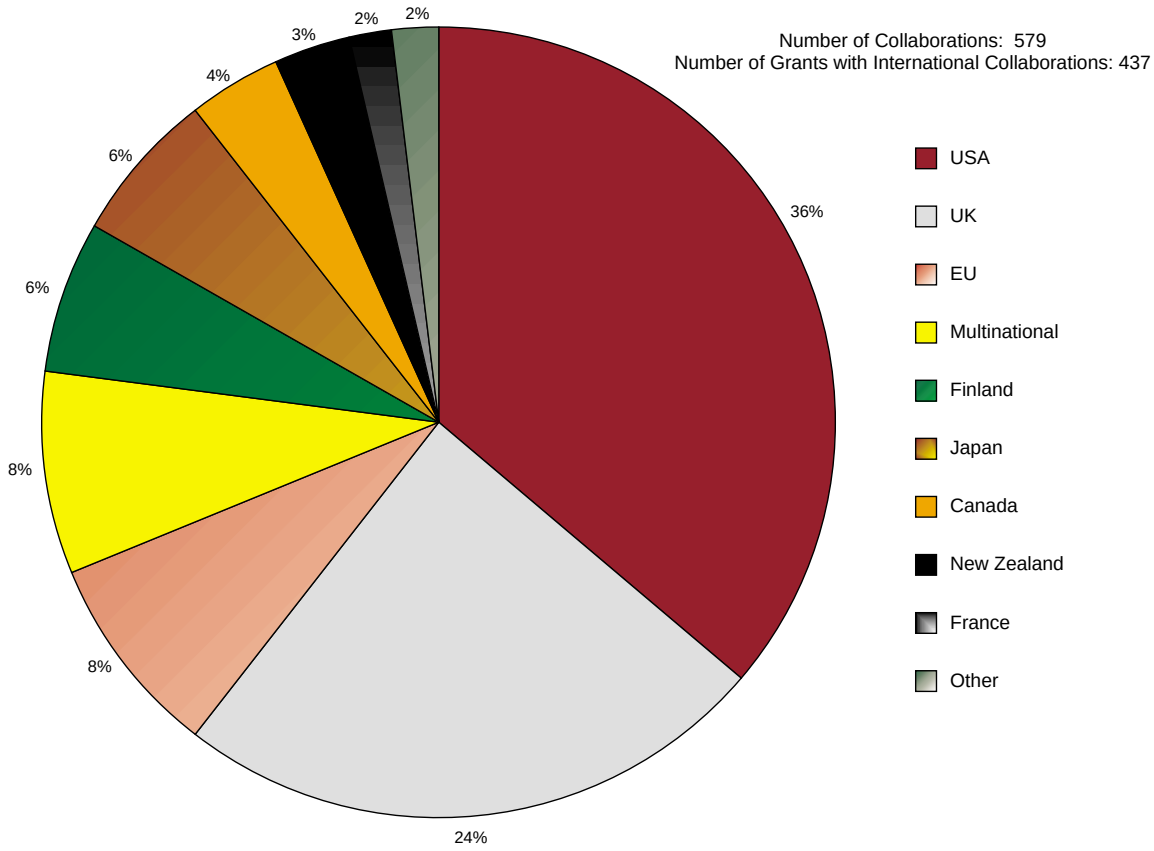
C4 NHMRC Grants – Overview

Table C1 lists the NHMRC grant programs and the estimated international portion of the expenditure for each program. Figures C1 to C4 illustrate the overall characteristics of the estimated total $26.9m expenditure on 579 international collaborations through 437 grants. Program details and estimation methods follow in the next section.

Figures C1 and C2 illustrate the dominant position of the US as a collaborator on medical research. Of the 579 collaborations with overseas researchers, more than one third of these were with researchers based in the US. The UK ranks second with less than a quarter of all research collaborations. With the US and UK dominating collaborations, the rest of the world combined accounts for less than half of all collaborations. The number of collaborations exceeds the number of projects since each project may involve a number of international collaborators.

Figure C1

NHMRC – INTERNATIONAL S&T COLLABORATIONS BY COUNTRY



Source: The Allen Consulting Group estimates based on NHMRC data.
Note: **Other**: Germany, Kenya, Sweden and Switzerland. EU refers to the EU organisation as a whole.

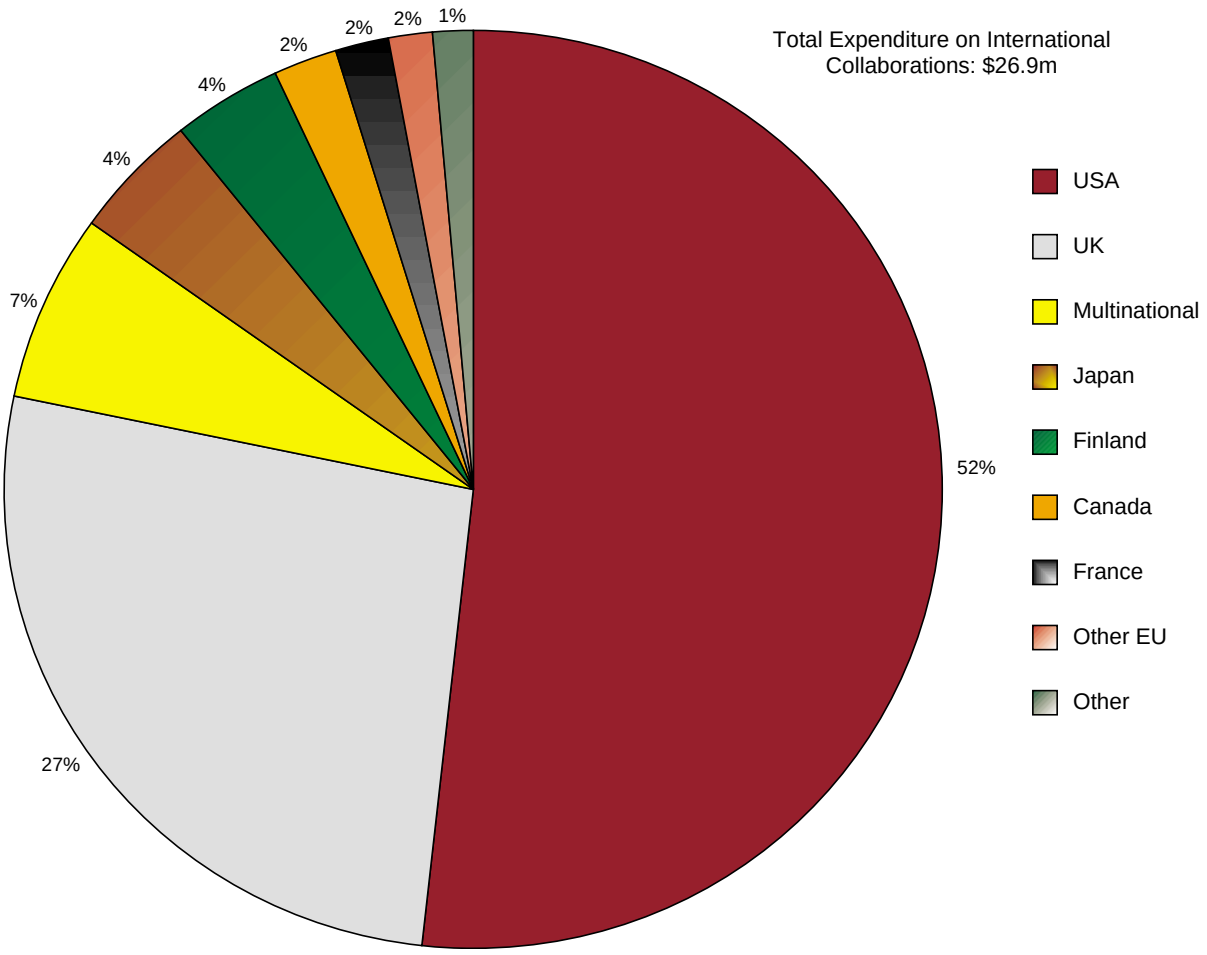
Figure C2 reflects similar patterns for expenditures. However, the dominance of the US is even more evident with half of all NHMRC medical research funding being spent on collaborations in the US alone. This compares to 36 per cent of *collaborations* with the US. For the UK the share based on expenditure is similar to that for collaborations (24 per cent). Projects with more than six collaborating countries are designated as 'multinational' collaborations and rank next with a distant third, in terms of expenditure, at eight per cent. Include as well in the multinational category are collaborations with international organisations. An example of a multinational a multinational project is the Global Biodiversity Information Facility (GBIP), which is described in detail below.

The case of the EU illustrates the limitations of using a single measure for the extent of international collaborative activity. Figure C1 indicates that the EU as an organisation represents eight per cent of total international collaborations, ranking third. This is because the EU/Australia Collaborative Grant program identifies a large number of collaborating groups that are potentially involved in joint research — with a total of 48 collaborations listed. However, in terms of expenditure, the extent of collaborations with the EU was limited to only two projects in 2002.

In terms of expenditure, the two EU Collaborative grants represent less than two per cent of the total value of international collaborations and therefore the expenditure of $57,190 for the EU collaborations are not shown separately on the pie chart. Hence, the share of expenditure for the EU is shown as part of the 'Other EU' group of countries for which expenditures represent less than two per cent of the total. In this case the 'Other EU' group includes the EU organisation, Germany and Sweden ($407,420) Measuring collaborations alone, therefore, may lead to an incorrect inference about the extent of collaborations. Evaluating the distribution of *expenditures* by country effectively weights the number of collaborations by the level of expenditures and gives a more complete picture of the extent of collaborations than the number of collaborations alone.

Figure C2

NHMRC - EXPENDITURE BY COUNTRY

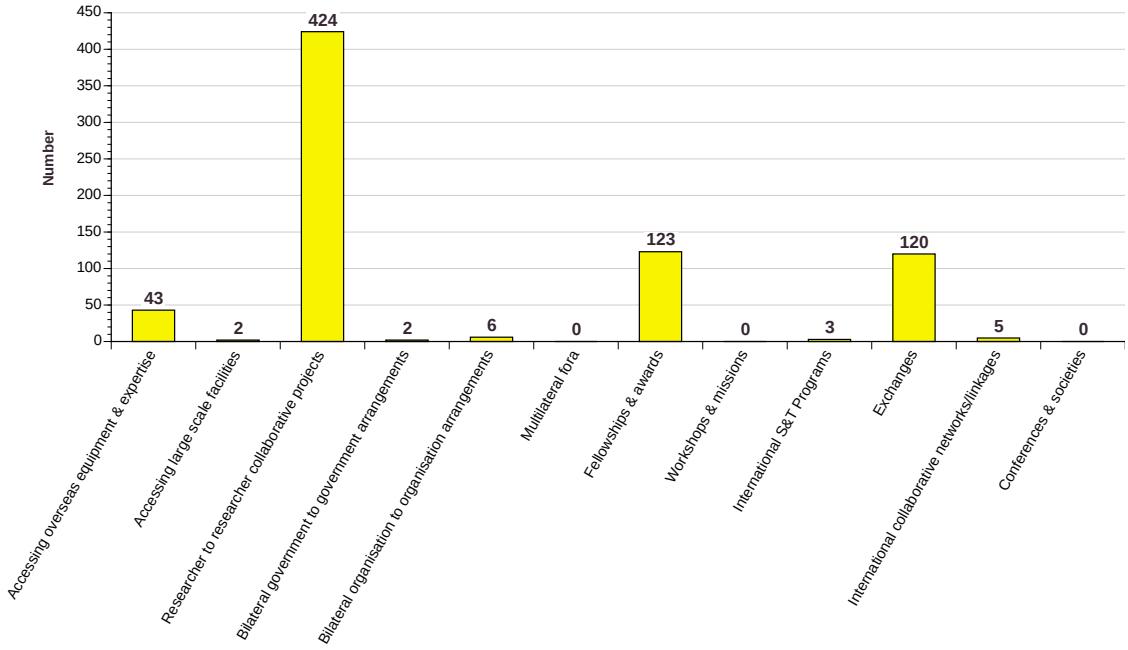


Source: The Allen Consulting Group estimates based on NHMRC data.
Note: **Other EU**: Germany, Sweden and the EU organisation as a whole. Other: NZ, Switzerland, Kenya.

Figure C3 illustrates the Purpose and Type of the 437 grants identified in Figure C1. The estimated 721 purposes identified in Figure C3 represent a number of grants and projects that were characterised as having more than one purpose. Most are characterised as being 'researcher-to-researcher collaborations' with this purpose dominated by the 114 Fellowships and all 306 Project Grants with international collaborations. 'Fellowships and exchanges' represent mainly the fellowships. Based on analysis of the sample of Project Grants, it is estimated that one purpose of 38 Project Grants was to 'access to overseas equipment and expertise'. However, it may be that this is a major purpose for many other grants as well but there is no way to estimate this with the current information. Other examples of accessing overseas equipment and expertise are the GBIF database and HUGO and Celera. These collaborations are described in detail below.

Figure C3

NHMRC - ACTIVITIES BY PURPOSE AND TYPE



Source: The Allen Consulting Group estimates based on NHMRC data.

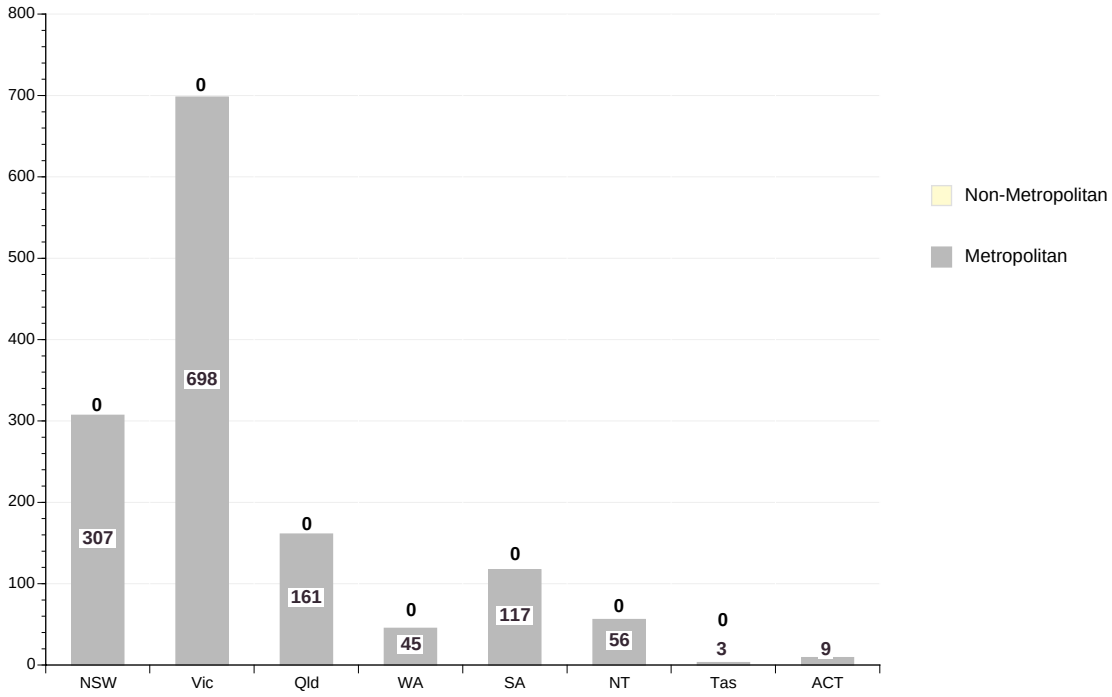
Figure C4 shows the distribution by geographical location of the 1,396 researchers estimated to be participating in international collaborative projects. Activity is concentrated at metropolitan universities and mostly in Melbourne. This is consistent with the pattern for all NHMRC grants. Where possible, the number of researchers was identified according to location but in many cases, the estimate includes only the grant recipient organisation hence, estimates should be interpreted as minimum numbers.

As expected, the main areas of research are Basic Science and Medical and Health Sciences. For the estimated 437 grants with international collaborations, 335 grants are in the NHMRC's classification of Basic Science (77 per cent) and 102 grants (23 per cent) NHMRC's Medical Science fields. The distribution between these two fields does not reflect the same distribution as all NHMRC grants.

Hence, the share of projects in Basic Science is estimated to be higher for the subset with international collaborations than for all NHMRC grants. For example, 27 per cent of NHMRC Fellowships are in Basic Science while 77 per cent of grants identified as international, are in Basic Science.

Figure C4

NHMRC - RESEARCHERS BY GEOGRAPHIC LOCATION



Source: The Allen Consulting Group estimates base d on NHMRC data.

For Project Grants, 53 per cent of all grants were in Basic Science in 2002 while 82 per cent were in Basic Science for the international group. There is a problem, however, with using these estimates to make inferences because of limitations of the data. For example, there are gaps in the data for the large number of fellowships where the field of research is not given.

Since NHMRC research codes are not the same as ASRC codes, it was necessary to re–assign codes in order to maintain consistency with the rest of this study. Hence, for the purpose of this study, the grants designated as Basic Science, according to the NHMRC codes are categorised here as Biological Sciences under the ASRC system. The Medical Science field under NHMRC is categorised under ASRC Medical and Health Sciences.

Since there are only two fields of research characterised for all NHMRC grants, no separate figure is provided in this appendix. However, NHMRC data is reflected in the overall Commonwealth summary in Chapter 3 of this study.

C5 NHMRC - Grant Program Analysis

The grants listed in Table C1 and summarised in Figures C1 to C4 are described in this section with an analysis of their individual characteristics. These grants provide for research in the Health and Medical fields as well as for Basic Science in a number of categories ranging from scholarships for one postdoctoral student to large Program Grants involving research centres and a number of researchers. For some programs, such as the INSERM grants, there is a requirement for international collaboration; however, most grant programs do not appear to include international collaboration *per se*, as a criterion. As a result, details of international collaboration for the large majority of programs are not available.

Although the data on international collaborations are not available, it is expected that international collaborations will be undertaken. For this reason, it is estimated that a significant percentage of the remaining 90 per cent of expenditures by the NHMRC on grant programs includes international collaborations. Without data available, however it was necessary to review available grant information. A description of the methodology follows in the next section.

C5.1 Project Grants

In order to estimate the amount of international collaborations involved in Project Grants, a sample of grants was analysed. Based on a sample of 78 individual Project Grants that were new in 2002, it is estimated that approximately $16m, or 10 per cent of total Project Grant expenditures were on international collaborations. Based on the sample, and as explained below, it is estimated that 306 Project Grants involved international collaborations, with a minimum of 360 international collaborations undertaken as part of these grant activities.

One-third of the collaborations sampled were with the US, with the UK representing a further third. Finland, Japan, Canada and New Zealand combined represented the final one-third. Expenditures follow a similar distribution, but with the US representing close to one-half of total expenditure on the collaborations.

The large majority of Project Grants with international collaborations (80 per cent) were classified as being in Basic Science. This is in contrast to the total of all Project Grants in 2002, where 53 per cent of all grants were in Basic Science. This suggests that international collaborations are more concentrated in the Basic Sciences than in Medical and Health Sciences. However, this inference is based on the sample of 78 Projects for 2002. This is an area where further analysis would be useful to test the results derived from sampling methods.

The analysis of individual grant applications indicated that the majority of research would be classified as 'researcher-to-researcher collaboration' while in a few cases there was an indication that an additional purpose of the collaboration was to access large facilities.

Melbourne was the centre for most international researchers funded by the 3-Year Project Grants in 2002 (51 per cent), with metropolitan NSW second (22 per cent) and Brisbane third (12 per cent). These results are consistent with the distribution of all Project Grants although the analysis here is based on researchers rather than number of grants. Hence, for Project and Program Grants, for example, there are a number of researchers noted in a location.

The sampling methodology for arriving at the estimates for Project Grant expenditure follows, including a discussion of the limitations of sampling.

Project Grant Sample

Out of the total of 2,419 NHMRC grants, 1,390 Project Grants were funded in 2002, with a total expenditure of $146.0m. Of these, 501 were 3-year Project Grants. Expenditure was $57.5m on these 501 grants in 2002. In order to characterise the international collaborations undertaken and financed by these grants it is necessary to analyse the extensive grant applications made by researchers. Due to time constraints, we sampled the new 3-Year Project Grants made in 2002. Equipment and Development grants were excluded, given these would apply mainly to domestic research leaving a total of 396 grants that were applied for in 2001 and started in 2002.

Expenditure on the 396 grants in 2002 was $49.0m. A sample of 78 grants was taken. Expenditure for these 78 in 2002 totalled $9.3m. Of these, 17 grants were identified as having international collaborations involved, representing 22 per cent of the sample of 78. Total expenditure for these 17 grants was $2.1m and the estimate of expenditure on international collaborations for these 17 is $1.0m. This expenditure of $1.0m represents 11 per cent of expenditure of $9.3m for the sample of 78.

Given the sample of every fifth successful grant application, it is expected that the distributions found for the sample can be used to estimate the distribution for the 3-Year Project Grant program as a whole. The share of international expenditures in the sample was used to scale up to the total of all Project Grants. Hence, based on the sample results, 22 per cent of all Project Grants are estimated to be international and 11 per cent of all expenditure on Project Grants is estimated to be international. However, sampling has its drawbacks. It is expected that the ANU was involved in international collaborations, however our sample of 78 did not identify any Project Grant applications that involved international collaboration that also involved ACT researchers.

Ideally, if all grant applicants were required to identify international collaborative activities and estimate the extent of their international collaborative activities, sampling and estimation would not be required and better estimates would be possible. Given that this information is not available, sampling was required and its limitations must be accepted.

C5.2 Program Grants

The NHMRC defines Program Grants as those that support teams of researchers to pursue broadly based collaborative research activity. The team is expected to contribute new knowledge at a leading international level in important areas of health and medical research, develop novel ideas and approaches, tackle problems for which longer term stable funding is essential, develop training and career development opportunities within the team, and facilitate collaborative use of specialised facilities or expertise.[69] The total 2002 expenditure on Program Grants was $62.5m (Table C1).

NHMRC identified six Program Grants that have an international dimension. An extensive review of the files was undertaken for all six of these Program Grants, including grant applications and interim reports. Of these six, two had detailed their international collaborations. These two are characterised for this study. One of the two Program Grants is concerned with the Human Genome and the other with Inflammatory Disease. Total expenditure for these grants in 2002 was $1.3m. It is estimated that of the $1.3m total expenditure, $0.835m could be characterised as the portion devoted to the international dimension of the collaborative S&T expenditures. According to the documentation reviewed, both programs had more than six collaborating countries involved with a total of 31 international collaborators, 15 domestic associate investigators and eight domestic Chief Investigators (CI's). Foreign CI's are not permitted with this grant type. These characteristics are included in summary figures for the NHMRC (Figures C1 to C4) with the 31 international collaborations characterised as 'multinational'.

[69] NHMRC, 2001 *Annual Report*, p. 116.

For the two international Program Grants identified, 38 domestic researchers were identified, located in metropolitan NSW, Victoria and South Australia. One was categorised as Biological Sciences and one as Medical and Health Sciences.

C5.3 Australian-European Union Health Research Collaboration

The NHMRC provided support towards Australian participation in projects selected for funding under the European Commission's Fifth Framework program. Support is provided for projects on quality of life and management of living resources. Two grants were made under this program totalling $57,190 in 2002, classified as (the ASRC field) Medical and Health Sciences. Some 48 collaborative groups are involved in this grant program in the EU. The purpose is identified in our analysis as bilateral government-to-government arrangements and international collaborative networks.

C5.4 Fellowships

Most Fellowships and virtually all scholarships are for domestic use, however, a number of grants are made so that Australian researchers can either gain international experience or to finance their return to Australia. Of the total of 488 Fellowships active in 2002, 114 were identified as having an international focus. These include the following, which we have labelled as MHF&S, in Table C1.

- Biomedical (C.J. Martin) Fellowships.
- Clinical (Neil Hamilton Fairly) Fellowships.
- Howard Florey Centenary Fellowship.
- Sidney Sax.

The terms of the grants typically include two years spent overseas and two years spent in Australia. Since the goal is to gain international experience, it is assumed here that all of these grants are international in nature. Hence, total expenditure is assumed to support international collaborations in any given year, whether or not the researcher is on his or her Australian portion of the Fellowship or overseas. Total expenditure on these Fellowships was $7m in 2002 for all 114 Fellowships.

Information is not readily available for the countries where all Fellowship holders will be located. NHMRC staff provided the distribution for the 56 of the 114 grantees who were overseas in 2002 and this distribution was applied to all grant holders. Given this assumption, 55 per cent were located in the US with 29 per cent in the UK. Remaining locations included Canada (4 per cent), France (4 per cent), Germany (4 per cent), Kenya (2 per cent), Sweden (2 per cent) and Switzerland (2 per cent).

C5.5 Industry Fellowship

In 2002, one Industry Fellowship for $80,000 was granted for an international collaboration that enabled a researcher from the University of Queensland to gain commercialisation skills and access facilities with an American firm.

C5.6 INSERM Exchange Fellowships

In 2002 there were six of these fellowships supporting French researchers in Australia for one or two years on an exchange basis. Australian researchers are supported by INSERM while in France. Total expenditure in 2002 was $298,042.

C5.7 Scholarships

The NHMRC identified these as mainly domestic with small amounts for travel and international collaborations. (Table C1)

C5.8 NHMRC Burnet Award

The goal of this award is to bring Australian researchers home and to extend opportunities for international collaborations. In 2002 there were two recipients with their characteristics noted below.

- Tony McMichael (ANU) — Research involves multinational collaborations including the World Health Organisation, on Public Health and epidemiology with $533,700 spent in 2002.
- Peter Doherty (University of Melbourne) — Basic Science pathology/immune system research involves US collaborations with $200,000 spent in 2002.

C5.9 Other Support for International Activities

Strategic Research Development Committee grants (SRDC)

The NHMRC identified the EME (Electromagnetic Energy) as the only SRDC with an international dimension in its research. The research is directed at identifying the health risks associated with using mobile phones. It is a multinational project involving 14 other partners with the research based in Sydney and $0.315m of expenditure in 2002.

GBIF

The Global Biodiversity Information Facility (GBIF) originated as an OECD megascience initiative and has become an international endeavour involving non-OECD participants. Over time, GBIF will grow into a distributed network of databases containing the world's biodiversity information. It will make biodiversity data widely available and improve information flows between scientists, industry and information managers by coordinating the collection, processing and dissemination of existing and new data in a standard digital form.

Australia was actively involved in the development of the Memorandum of Understanding (MOU) to establish GBIF. The then Minister for Industry, Science and Resources, Senator Minchin, signed the MOU in February 2001 on behalf of Australia for a period of five years.

Australia's annual membership fee for GBIF is US$100,000, which is shared equally by DEST, Environment Australia, CSIRO, ARC and NHMRC.

The NHMRC expenditure in 2002 for its membership share was $42,275, which is included in Figures C1 and C2 as a single multinational collaboration. Figures C2 to C4 include GBIF expenditure in the following way. Four purposes and type of activity are identified for GBIF. These are: 'accessing overseas equipment and expertise'; 'accessing large-scale facilities'; participating in 'international collaborative networks'; and, participating in 'international S&T programs'. Field of science is Medical and Health Sciences and provides for access to overseas expertise for Australian researchers throughout the country. It is assumed that researchers in each metropolitan region are involved, however, actual numbers of researchers have not been estimated. One researcher has been designated at each location, which should be interpreted to represent at least one team of researchers. More detailed information is required in order to make a better assessment of the numbers of researchers across the country who are participating.

Celera

A total of $1.5m in expenditure subsidises access to the American firm, Celera Genomic's, human genome database for Australian Researchers. The collaboration is with the US, field of science is Medical and Health Sciences and the subscription provides for access to overseas expertise for Australian researchers throughout the country.

HUGO

The NHMRC provides $50,000 for the Human Genome Organisation (HUGO) subscription based at the University of Adelaide. Collaborations are with multiple countries, the field of research is Medical and Health Sciences and in this case, it is assumed that the researchers involved are based in Adelaide.

NHMRC/Juvenile Diabetes Research Foundation (JDRF – US)

The US and Australia each committed to providing $5.0m over three years for the next phase of this established collaborative research project, however, NHMRC staff indicated there was no expenditure in 2002 since the next phase would start in 2002 3.

C6 Early Career Researchers

Information on Early Career Researchers is not collected consistently for most programs although there are various references to research assistants undertaking postdoctoral work on projects. However, for all C.J. Martin – Biomedical, Clinical – Neil Hamilton Fairley, Public Health – Sidney Sax and INSERM Fellowships, the recipient may not have had more than two years of postdoctoral experience from the date that the doctoral thesis was passed. There were approximately 114 of these active in 2002 although the length of grants is normally four years but varies from four to nine years. This means that some researchers clearly would be beyond five years postdoctoral, which is a common definition of early career.

Appendix D

Environment and Heritage Portfolio

The Environment and Heritage Portfolio comprises the Department of Environment and Heritage (Environment Australia), the Australian Antarctic Division, the Supervising Scientist Division, five statutory authorities (Australian Heritage Commission, Director of National Parks, Great Barrier Reef Marine Park Authority, Office of the Renewable Energy Regulator, and Sydney Harbour Federation Trust) and three executive agencies (the Australian Greenhouse Office, the Bureau of Meteorology, and the National Oceans Office). A number of organisations in the Portfolio receive significant amounts of Commonwealth funding for S&T (see Table D1).

While the majority of S&T activities in this portfolio are directed toward national issues, international cooperation is also an important component. Serious environmental problems are global in nature (for example, preservation of biodiversity, climate change, ozone depletion, deforestation and environmental pollution), and require international cooperation in addressing their causes, and developing and implementing effective solutions. International activities in this portfolio include:

- participation in multilateral and regional fora (for example, the Governing Council of the United Nations Environment Programme (UNEP), and the South Pacific Regional Environment Program (SPREP));
- bilateral activities on environmental and sustainable development issues (particularly in the Asia-Pacific region); and
- 'reporting' to international organisations on Australia's commitments to various international conventions.

In sum, the Portfolio has international activities across a range of issues including Biodiversity, Chemicals (international chemical management and international standards), Greenhouse, Hazardous Waste, Heritage, Marine Issues and Wetlands. An example of international activities involving S&T collaboration is the Intergovernmental Panel on Climate Change (IPCC), where Australian scientists contribute to the assessment of the state of knowledge on climate change and thereby contribute to the international response on this issue.

As has been the case with other Portfolios and agencies, mapping the use of Commonwealth funds for international S&T collaboration in the Environment and Heritage Portfolio has been difficult, particularly the provision of information, which is not collected in a systematic manner. Table D1 lists those agencies in the Portfolio that responded to a request for this information. From this data it appears that $4.1m, or less than 3 per cent of the Commonwealth funds provided to the Portfolio for S&T, were directed towards international S&T collaborations in 2001-2. It is likely, however, that this underestimates the true extent of Portfolio involvement in international S&T.

Table D1

PROGRAMS SUPPORTING INTERNATIONAL S&T

Environment and Heritage Portfolio	*Year*	*Commonwealth S&T Expenditure ($'000)*	*International S&T Expenditure ($'000)*
Environment Australia International Activities (Ozone Protection Program)	2001-2	N/A	53
Antarctic Division	2001-2	92,000	3,673
Environmental Research Institute of the Supervising Scientist	2001-2	8,400	0
Bureau of Meteorology	2001-2	9,400	101
Australian Biological Resources Study	2001-2	4,500	47
Australian Greenhouse Office	2001-2	29,100	216
Great Barrier Reef Marine Park Authority	2001-2	N/A	49
National Oceans Office	2001-2	2,100	0
Total	2001-2	145,500	4,139

Source: The Allen Consulting Group estimates derived from data provided by Environment Australia and the agencies. Figures for Commonwealth S&T expenditure sourced from Minister Nelson's and Minister McGauran's joint press release, May 13, 2003, www.dest.gov.au/ministers/nelson/budget03/table2.pdf and Tables 3 & 4.

Note: N/A = Not Available

D1 Analysis

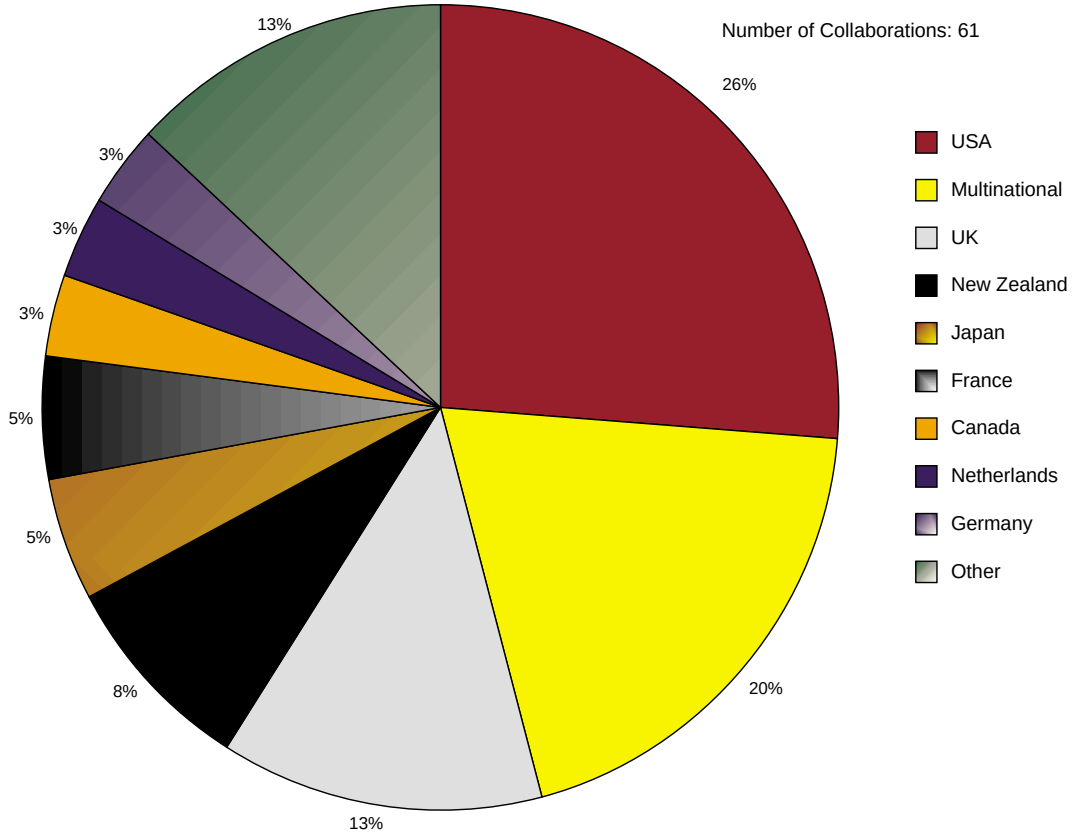
The analysis of international S&T collaborations for the Environment and Heritage Portfolio in 2001-2 is conducted in three parts. First, an overview analysis is provided that encompasses information generated from all agencies in the Portfolio (see Figures D1 to D5). Second, a separate analysis of the Australian Antarctic Division (AAD), as approximately 90 per cent of international S&T expenditure in the Portfolio was undertaken by this Division (see Figures D6 to D9). The third section contains a discussion of international S&T activities conducted by other organisations in the Portfolio.

A total of 61 collaborations were analysed in Figure D1, almost a third of which were with the US (due largely to the high number of AAD collaborations conducted with the US). Other collaborative partners of significance include multinational, the UK and New Zealand. When the AAD is excluded from Environment and Heritage Portfolio collaborations, the most common collaborative partner is multinational (30 per cent of collaborations), with the US and UK ranking second (both with 13 per cent). In terms of expenditure by country, the US' dominance increases to 36 per cent, followed by the UK, Canada and New Zealand (see Figure D2). Again, if the AAD is excluded from an analysis of expenditure on Environment and Heritage collaborations, the proportion of expenditure on multinational collaborations increases to 67 per cent, followed by the UK at 10 per cent and the US at 6 per cent. This finding suggests that the AAD's primary partner for international activities is the US, whereas for the remainder of the Environment and Heritage Portfolio it is multinational.

Figure D3 indicates that Physical Sciences, Earth Sciences and Biological Sciences were the predominant fields of research, respectively. However, in terms of expenditure on field of research, 53 per cent was allocated to Physical Sciences (all contributed by AAD), followed by Earth Sciences (22 per cent) and Biological Sciences (17 per cent) (no figure provided).

Figure D1

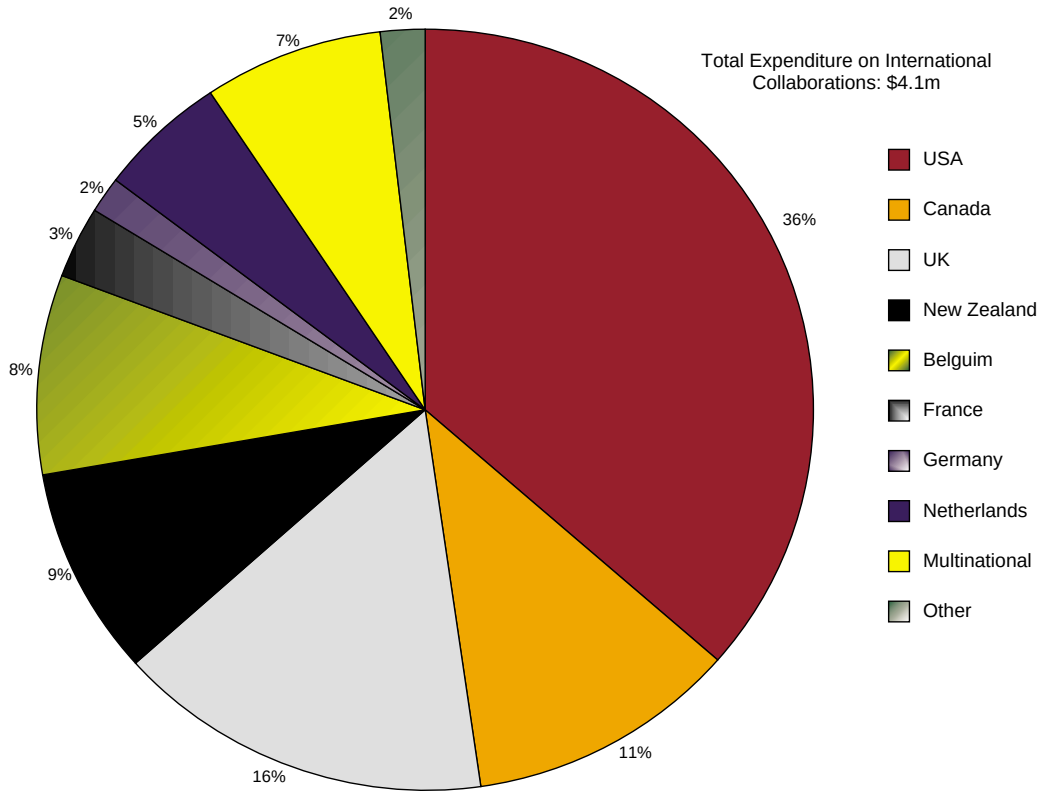
ENVIRONMENT AND HERITAGE – COLLABORATIONS BY COUNTRY



Source: The Allen Consulting Group estimates based on data provided by agencies in the Environment and Heritage Portfolio.
Note: **Other:** Austria, Belgium, China, Iceland, Indonesia, Mexico, Mozambique, Norway

Figure D2

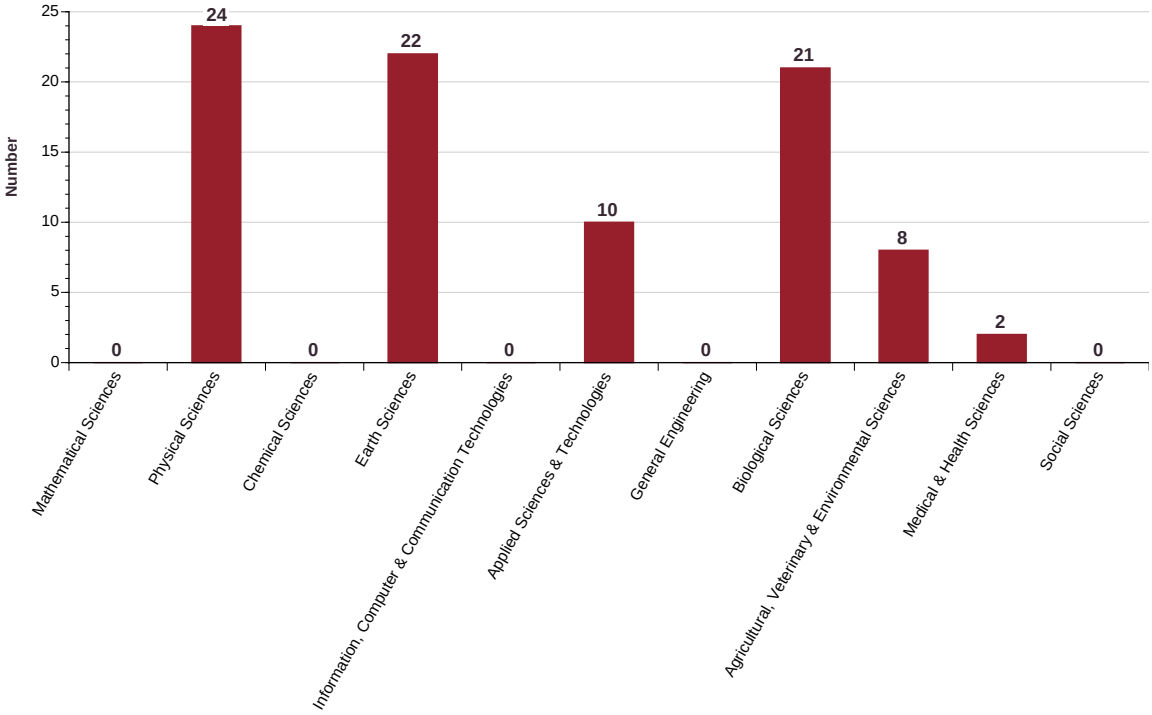
ENVIRONMENT AND HERITAGE – EXPENDITURE BY COUNTRY



Source: The Allen Consulting Group estimates based on data provided by agencies in the Environment and Heritage Portfolio.
Note: **Other**: Japan, China, Austria, Iceland, Indonesia, Mexico, Mozambique, Norway

Figure D3

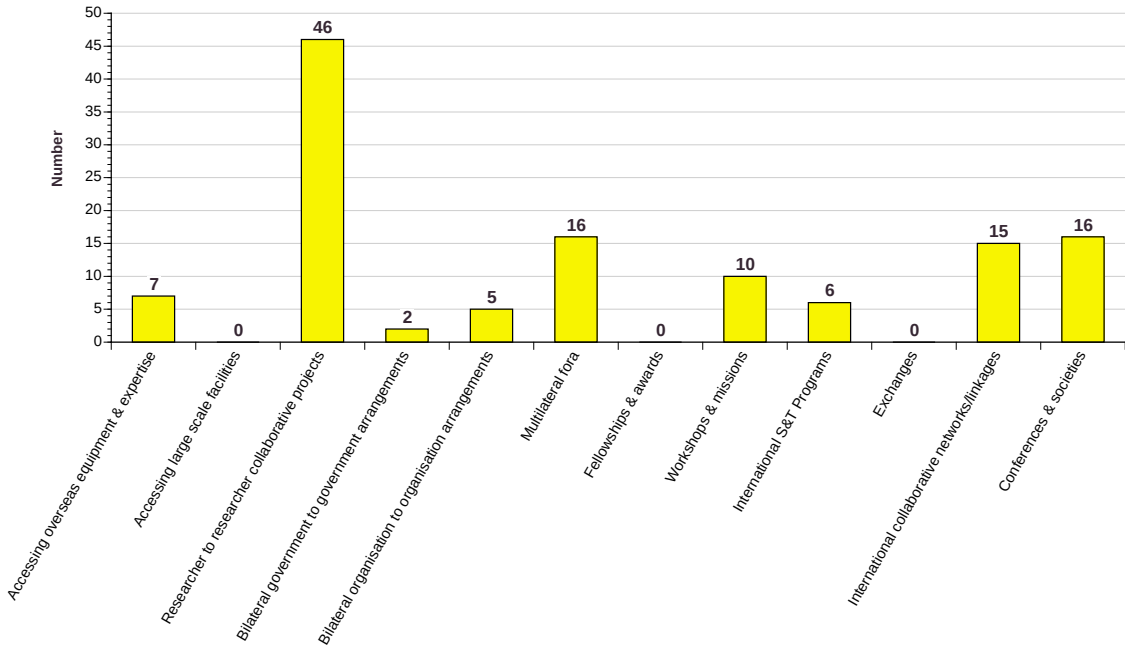
ENVIRONMENT AND HERITAGE – ACTIVITIES BY FIELD OF RESEARCH



Source: The Allen Consulting Group estimates based on data provided by agencies in the Environment and Heritage Portfolio.

Figure D4

ENVIRONMENT AND HERITAGE – ACTIVITIES BY PURPOSE AND TYPE



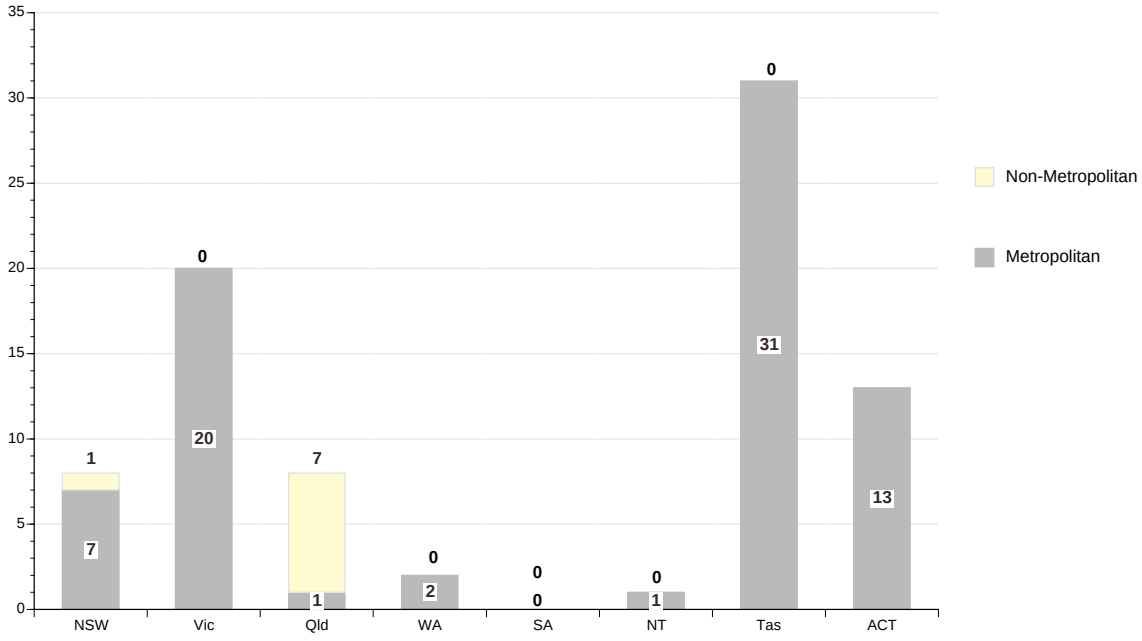
Source: The Allen Consulting Group estimates based on data provided by agencies in the Environment and Heritage Portfolio.

Figure D4 shows that the most common purpose of international activities in this Portfolio is 'researcher-to-researcher' collaborations. This purpose was also high for the AAD, where all international collaborations were categorised in this manner. A second-level cluster of activities by purpose and type exists for 'multilateral fora', 'conferences and societies', and 'international collaborative networks/linkages'. Australia's contribution to international conventions and issues relating to the environment is also reflected in Figure D4, where the purpose of an activity includes 'multilateral fora' and to a lesser extent for 'workshops and missions' and 'international S&T programs'.

In terms of location, activities by the AAD researchers in Tasmania and the Bureau of Meteorology (BOM) researchers in Melbourne dominate (see Figure D5). The group of researchers from non-metropolitan Queensland are associated with the Great Barrier Reef Marine Park Authority (GBRMPA).

Figure D5

ENVIRONMENT AND HERITAGE – RESEARCHERS BY GEOGRAPHIC LOCATION



Source: The Allen Consulting Group estimates based on data provided by agencies in the Environment and Heritage Portfolio.

D2 Australian Antarctic Division

D2.1 Overview

From its headquarters in Tasmania, the AAD undertakes research in biology, astronomy, geosciences, glaciology, human biology, oceanography and atmospheric sciences. It operates in Australian Antarctic Territory, as well as the Territory of Heard and McDonald Islands.

Support for international collaborations is calculated from 'in-kind support' provided by the AAD and attributed to a researcher travelling on voyages to the Antarctic. Such support covers transport (a berth on ship), accommodation on base, food and specialised clothing and equipment.

D2.2 Analysis

As stated earlier, AAD expenditure for international S&T collaborations represents the majority of the Portfolio's international S&T expenditure. In 2001-2, AAD estimates that expenditure on international collaborations totalled $3.7m, with the Division participating in 20 collaborations (although total collaborations is believed to have been underestimated).

Figures D6 and D7 indicate that approximately 40 per cent of both expenditure on and number of AAD collaborations, involved the US. The UK, NZ and Canada collectively represent another third of both expenditure on and number of AAD collaborations. The remaining five collaborating countries – Japan, the Netherlands, Germany, France and Belgium – each represented five per cent of total collaborations. When comparing the country rankings for number of collaborations with expenditure on collaborations, it appears that Canadian and Belgian collaborations were relatively higher in cost.

The analysis by field of research, shown in Figure D8, was conducted using figures for all AAD research projects (including those with international collaborations). The distribution of fields of research remains fairly consistent for the two types of AAD projects, with most projects being in the Physical, Biological and Earth Sciences respectively. There were fewer international collaborations in Applied Sciences and Technologies than for all projects. In terms of expenditure by field of research (for AAD projects with international collaborations), Physical Sciences received 59 per cent of funds, followed by Biological Sciences (18 per cent), Earth Sciences (17 per cent) and Applied Sciences and Technologies (6 per cent) (Figure not provided).

All projects were identified as researcher-to-researcher collaborations, therefore, a figure has not been produced here. It should be noted, however, that these collaborations are also governed by inter-governmental treaties.

As expected, Figure D9 illustrates that most of the Australian AAD researchers were located in Tasmania. Almost one quarter were, however, located in Victoria with a minority in NSW, the ACT and WA.

D3 Other International Activities

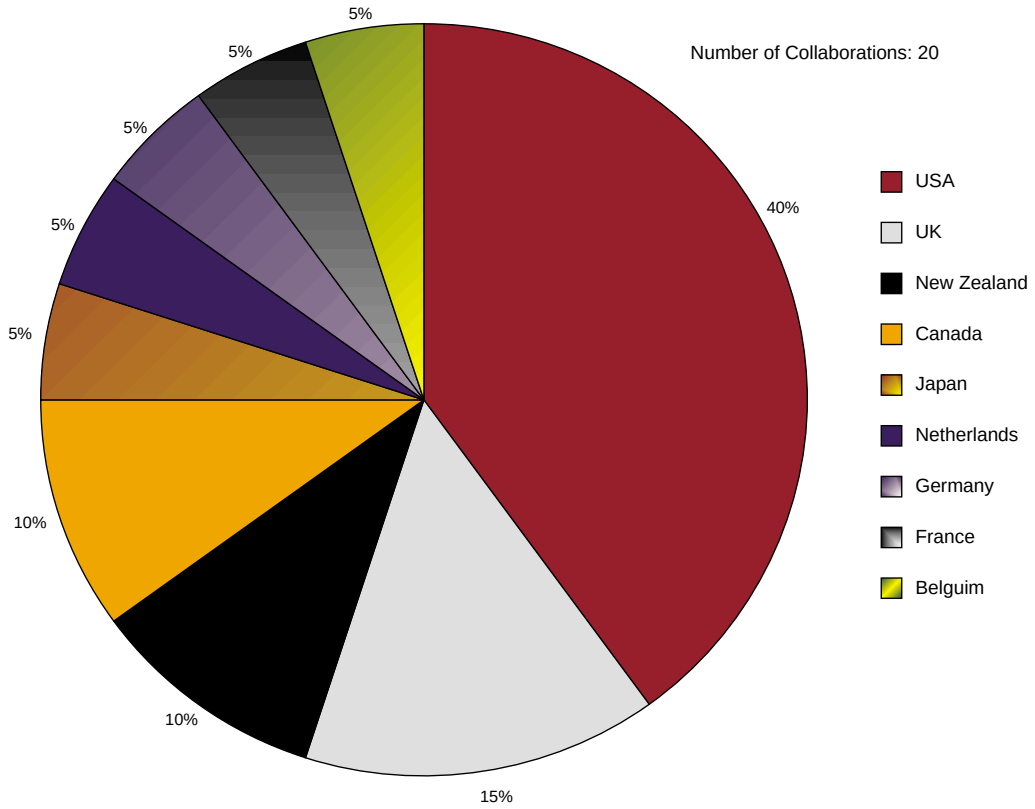
International activity undertaken by Environment Australia (EA) was limited to the Ozone Protection Program, which amounted to $53,225, and two 'multinational' collaborations in the field of 'Applied Sciences and Technologies' and 'Agricultural, Veterinary and Environmental sciences'. These efforts can be characterised mainly as 'multilateral forums', 'international S&T programs' and 'international collaborative networks/linkages'. The researchers are located in Metropolitan NSW and the ACT.

D3.1 Environmental Research Institute of the Supervising Scientist

The Supervising Scientist undertakes environmental research and reviews the environmental performance of uranium mines in the Alligator Rivers Region (in the Northern Territory), to ensure the protection of Kakadu National Park from the potential impacts of uranium mining. The Environmental Research Institute of the Supervising Scientist (ERISS) is located in Darwin and reports to the Supervising Scientist.

Figure D6

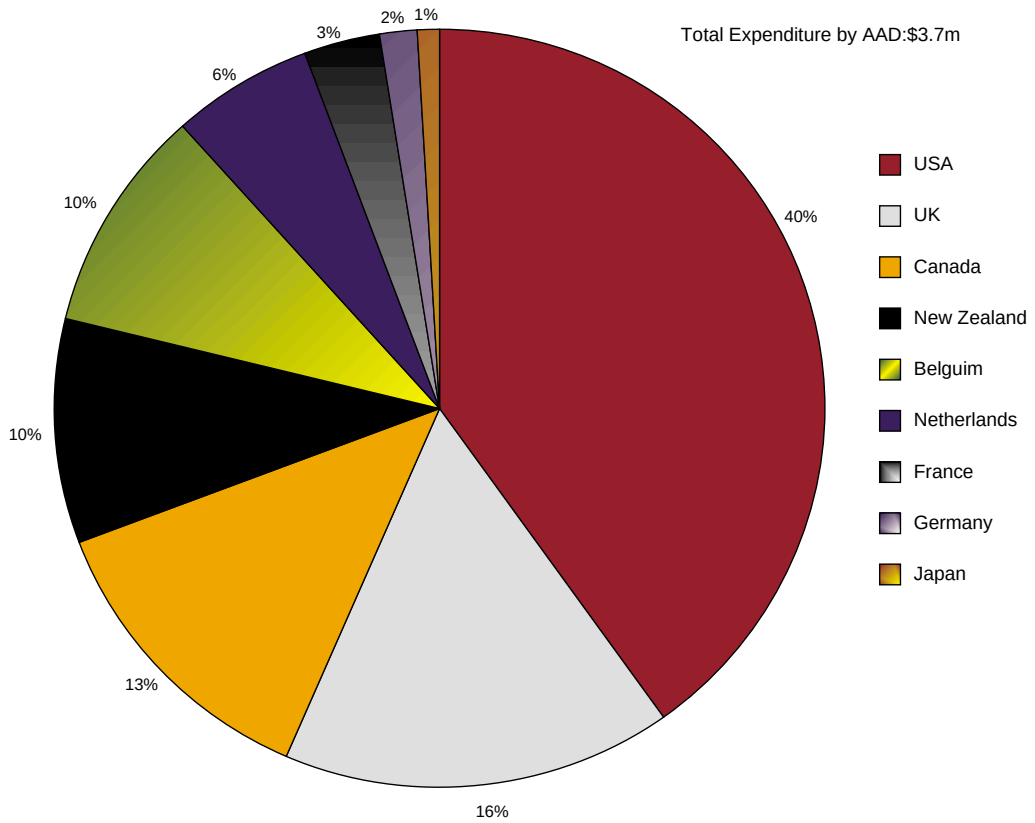
AAD – COLLABORATIONS BY COUNTRY



Source: The Allen Consulting Group estimates based on data provided by agencies in the Environment and Heritage Portfolio.

Figure D7

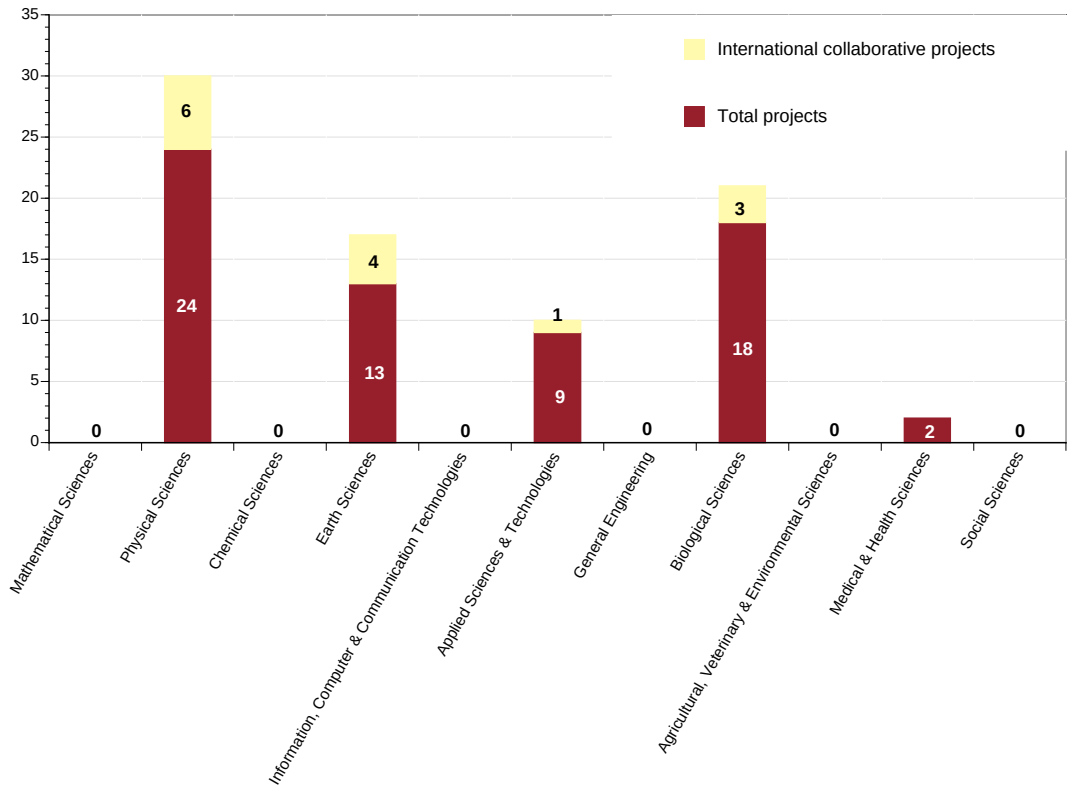
AAD – EXPENDITURE BY COUNTRY



Source: The Allen Consulting Group estimates based on data provided by agencies in the Environment and Heritage Portfolio.

Figure D8

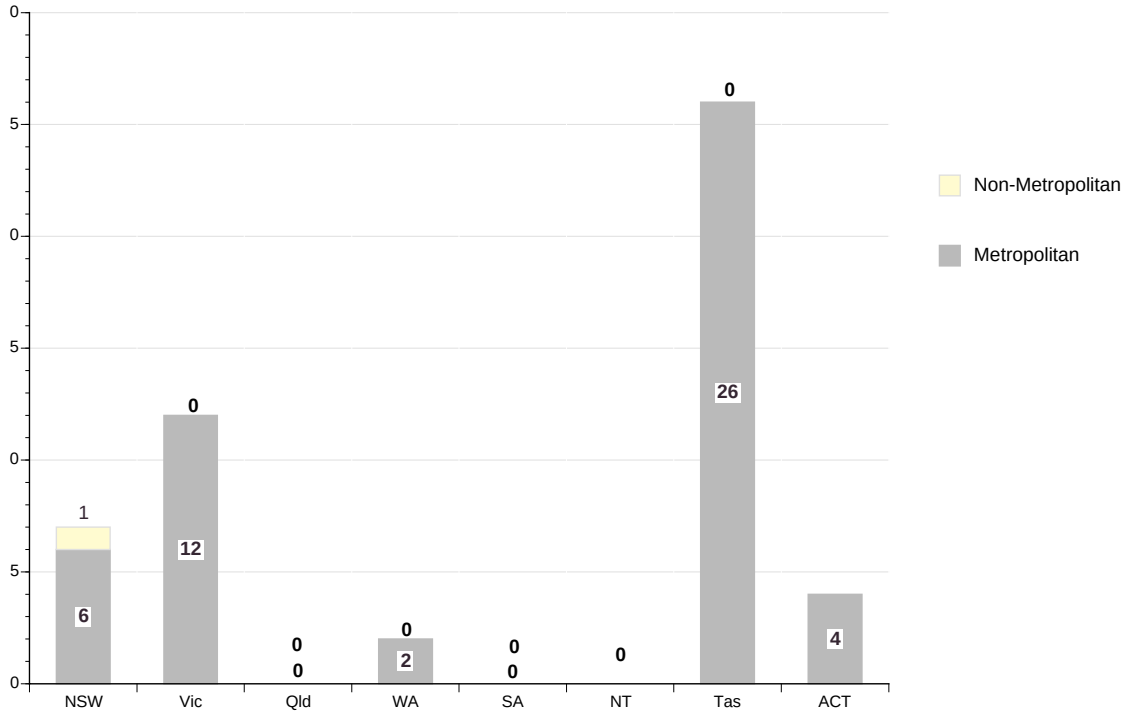
AAD – ACTIVITIES BY FIELD OF RESEARCH



Source: The Allen Consulting Group estimates based on data provided by the AAD

Figure D9

AAD – RESEARCHERS BY GEOGRAPHIC LOCATION



Source: The Allen Consulting Group estimates based on data provided by the AAD.

The Supervising Scientist provides technical and policy advice to the Minister of Environment and Heritage on a wide range of scientific and mining-related environmental issues of national importance. The Supervising Scientist also conducts more broadly based environmental research on issues of national significance. Most of the international activities of the Supervising Scientist are undertaken on a fee-for-service basis and are therefore not funded by the Commonwealth Government.

D3.2 The Bureau of Meteorology

The Bureau of Meteorology (BOM) is involved in a range of international research through the Bureau's Meteorology Research Centre. The BOM is also engaged in other international S&T activities including the World Meteorology Organisation.

In 2001-2, the BOM indicated that there were six international S&T projects with a total expenditure of $100,713. Expenditure on international activities primarily involved the US (27 per cent) and the UK (21 per cent), with similar proportions of total collaborations involving these nations. New Zealand, Japan and France each represented about 9 per cent of expenditure on collaborations with the remaining 30 per cent distributed over France, Austria, Indonesia, China, Germany and the Netherlands.

The field of research for each of the six international collaborations was Earth Sciences. The main purpose and type of these activities was 'conferences and societies', although 'researcher-to-researcher collaborations', 'bilateral organisation-to-organisation arrangements', 'workshops and missions', 'international S&T programs' and 'international networks/linkages' were listed as equally important. Australian-based researchers were mainly located in Victoria and the Northern Territory.

D3.3 Australian Biological Resources Study

The main aim of the Australian Biological Resources Study (ABRS) is to provide a taxonomic knowledge-base in support of the conservation and sustainable use of Australia's biodiversity. The ABRS received $4.5m of Commonwealth funds for S&T in 2001-2. Its international S&T expenditure for the same year was estimated at $47,327 for three collaborations. The purpose of these collaborations was 'researcher to researcher collaboration', in the field of biological sciences (in the area of taxonomy).

This summary seems to underestimate the full extent of ABRS' international activities, such as its participation in international fora and projects including, the Global Taxonomy Initiative and the Global Biodiversity Information Facility. The ABRS also provides small travel grants to postgraduate students to attend international conferences, as well as a grant-in-aid to assist with the annual appointment of the Australian Botanical Liaison Officer at the Royal Botanic Gardens, Kew UK.

D3.4 The Australian Greenhouse Office

The AGO is the world's first government agency dedicated to reducing greenhouse gas emissions. It was established in 1998, as a separate agency within EA, to provide a 'whole of government' approach to greenhouse matters.

The AGO provided information on three international S&T activities, with a total expenditure of $216,000. All projects were multinational in nature and involved the on-going evaluation of climate change resulting from the build-up of greenhouse gasses worldwide. The AGO participates in a number of international multilateral fora and undertakes negotiations for Australia within the framework of international collaborative networks/linkages. Participation of Australian staff in such international activities encompasses most of the costs identified by the AGO. These staff are mainly based in the ACT.

D3.5 The Great Barrier Reef Marine Park Authority

The GBRMPA manages the Great Barrier Marine Park and is the lead agency for Great Barrier Reef World Heritage Area issues. The GBRMPA is the principal adviser to the Commonwealth government on the care and development of the Great Barrier Reef Marine Park. Its goal is to provide for: the protection, wise use, understanding, and enjoyment of the Great Barrier Reef in perpetuity, through the care and development of the Great Barrier Reef Marine Park.

In 2001-2, GBRMPA estimates that $49,600 was spent on seven projects which involved international S&T collaboration. The field of science was exclusively 'Marine Environment' and categorised as Agricultural, Veterinary and Environmental Sciences for our analysis. The purpose and type of these international collaborations was categorised as 'multilateral fora', 'workshops and missions', 'international collaborative networks/linkages' and 'conferences and societies'. Researchers were based in non-metropolitan Queensland.

D3.6 The National Oceans Office

The role of the NOO is to:

- provide secretariat and technical support to the National Oceans Ministerial Board, the National Oceans Advisory Group and Regional Marine Plan Steering Committees;
- coordinate the development of Regional Marine Plans;
- coordinate the overall implementation and further development of Australia's oceans policy;
- act as the main administrative coordination point between the Commonwealth, States and Territories on oceans policy issues;
- coordinate and distribute information to all stakeholders on oceans policy and regional marine planning matters; and
- provide advice to the National Oceans Ministerial Board on marine research priorities related to Australia's Oceans Policy.

Australia's Oceans Policy was launched in December 1998 to manage 16 million square kilometres of oceans between 3 and 200 nautical miles from the coast — Australia's Exclusive Economic Zone.

In 2001-2 the NOO incurred no identifiable expenditure on international S&T, although it did receive $2.1m of Commonwealth funds for S&T. NOO has subsequently embarked upon a number of initiatives that will result in international S&T expenditure in the future.

Appendix E

Other Portfolios

This Appendix reviews international S&T collaboration among other portfolios: the Industry, Tourism and Resources Portfolio; the Foreign Affairs and Trade Portfolio; and the Communications, Information Technology and the Arts Portfolio (see Table E1).

Table E1

OTHER PORTFOLIO INTERNATIONAL S&T ACTIVITIES

	Year	Commonwealth S&T Expenditure (1) ($'000)	International S&T Expenditure Analysed ($'000)
Industry, Tourism and Resources Portfolio	2001-2		
Geoscience Australia		81,300	0
Foreign Affairs and Trade Portfolio (2)	2001-2		
Australia-Korea Foundation	2001-2	720	360
Indian Ocean Rim Association for Regional Cooperation Research Program	2001-2	108	108
Australian National Commission for UNESCO	2001-2	50	25
Commission for the Conservation of Antarctic Marine Living Resources	2001-2	193	193
International Atomic Energy Agency	2001-2	6,095	3,047
Organisation for Economic Cooperation and Development (OECD) (3)	2001-2	1,000 (2)	1,000 (2)
United Nations Educational, Scientific and Cultural Organisation (UNESCO)	2001-2	10,040	3,347
Australian Centre for International Agricultural Research (ACIAR)	2001-2	36,700	25,635
Communications, Information Technology and the Arts Portfolio	2001-2	75,400	100
National Science and Technology Centre (Questacon)(4)	2001-2	9,600	N/A

Source: The Allen Consulting Group
Note: 1. Some Commonwealth S&T Expenditures are sourced from Minister Nelson's and Minister McGauran's joint press release, May 13, 2003 (http://www.dest.gov.au/ministers/nelson/budget03/table3.pdf)
2. Values for international S&T expenditure by DFAT are Allen Consulting Group estimates.
3. OECD undertakes international S&T activities in several Directorates as well as the IEA and NEA. The share of annual membership is shown here.
4. The National Science and Technology Centre moved into DEST in 2002-3.

E1 Industry, Tourism and Resources Portfolio

Since the departure of the science function to DEST in 2001-2, the Department of Industry, Tourism and Resources (ITR) has undertaken little activity in international S&T. Relevant activities in 2001-2 included participation in activities of the International Energy Agency, and the OECD. In addition, ITR staff located at overseas posts undertake some international S&T activities. These expenditures have not been quantified.

ITR contributes to IAP–IST Showcasing activities reported in the Education, Science and Training Portfolio, where these expenditures have been included in this analysis.

ITR agencies undertaking international S&T activities include the Australian Government Analytical Laboratories, the IPS Radio and Space Services, Biotechnology Australia and IP Australia. The international expenditures of these agencies is estimated to be very small and has not been included. Geoscience Australia undertakes research in mineral and petroleum exploration and mapping, however, they have indicated that they made no international S&T expenditures in 2002.

E2 Foreign Affairs and Trade Portfolio

E2.1 Australian Centre for International Agricultural Research

The Australian Centre for International Agricultural Research (ACIAR), a component of the Commonwealth's development cooperation programs, is a statutory authority within the Foreign Affairs and Trade Portfolio with the role of encouraging Australian agricultural scientists to apply their expertise to the development of research projects that benefit developing countries. ACIAR research projects are developed according to Australian aid program priorities and research strengths, along with the agricultural research priorities of partner countries. The primary purpose is to provide assistance, or aid, for developing countries. However, since the primary activity financed by ACIAR is research, their international collaborative activities have been included in this study.

There are four broad research themes:

- meeting rising demand for animal protein;
- improving the productivity and efficiency of food crop and forestry systems;
- better environments from better agriculture; and
- linking farmers to markets.

ACIAR's activities are directed toward developing countries in five regions: Papua New Guinea and the Pacific Islands; Southeast Asia; North Asia; South Asia; and Southern Africa.

A high proportion of ACIAR's funding is directed towards international collaboration, in keeping with the organisation's primary purpose of delivering international aid (see Table E1). Apart from its primary activities of bilateral research ($26m in 2001-2) and multilateral research ($10.5m in 2001-2) ACIAR provides annual funding in the order of $1m for the training of 40 people from partner countries. It is also estimated that for every dollar of ACIAR research funding, the Commonwealth or State Governments provide matching funds in terms of in-kind support. ACIAR also acknowledges that additional spill-over benefits accrue to Australia from its international activities, namely from the economic development and improved welfare of trading partners, as well as from increased bio-security for Australia.

Analysis

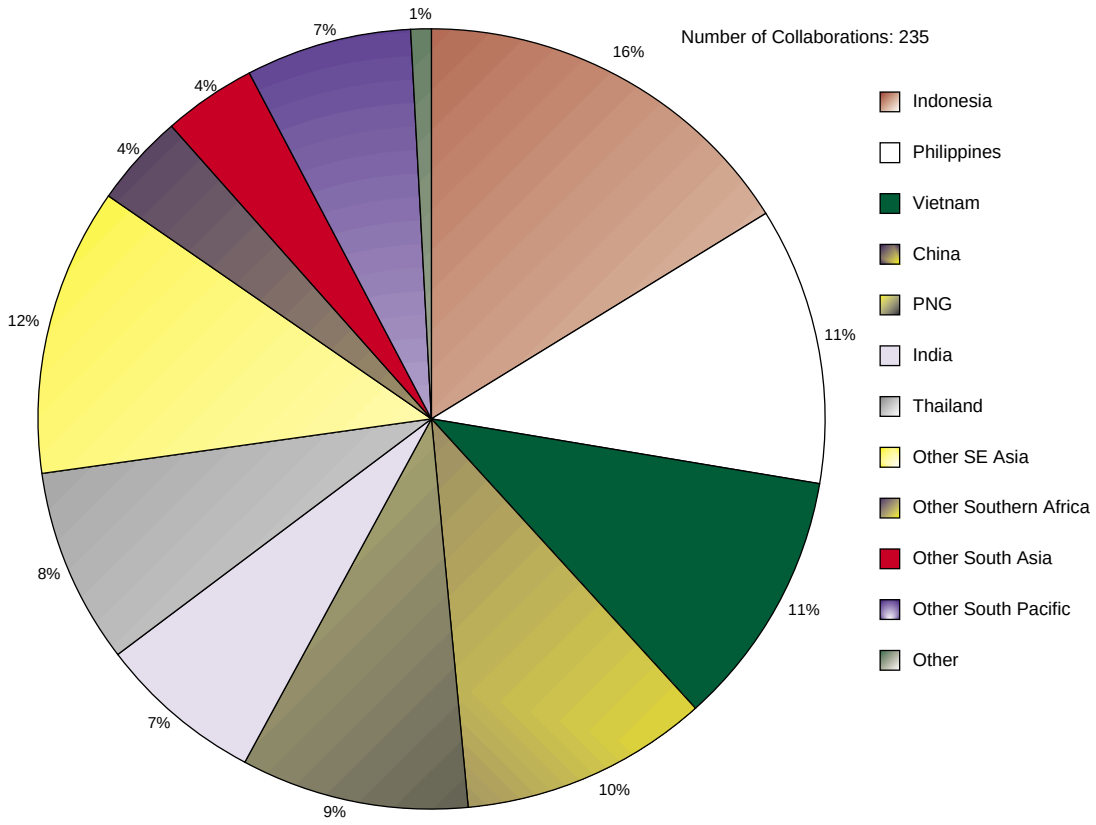
Information provided by ACIAR for international S&T activities totalled an estimated $26m of expenditure on international research projects in 2001-2. It is noteworthy that this amount is similar to the estimated total expenditure on international collaborations funded by NHMRC grants.

ACIAR's international S&T activities are characterised in Figures E1 to E3. In Figures E1 and E2, the analysis shows that ACIAR's international collaborations are concentrated among seven countries (Indonesia, Philippines, Vietnam, China, PNG, India and Thailand). These countries comprise roughly two thirds of ACIAR's collaborations, both in terms of numbers and expenditures. Indonesia has the highest share of collaborations (16 per cent) and expenditure (19 per cent) (see Figures E1 and E2). The distribution of collaborations, shown in Figure E1, is fairly even among the Philippines, Vietnam, China, and PNG (over a range of 11 to 9 per cent). In terms of expenditures on collaborations, given in Figure E2, China (14 per cent) and PNG (11 per cent) are ranked second and third, indicating that expenditure per collaboration is greater in these two countries.

All of ACIAR's international activities were undertaken the Agricultural, Veterinary and Environmental Sciences. The two main purposes of ACIAR activities were categorised as, 'bilateral-government-to government arrangements' and 'bilateral organisation-to-organisation arrangements'. The latter are in keeping with ACIAR's function as deliverer of aid to developing countries.

Figure E1

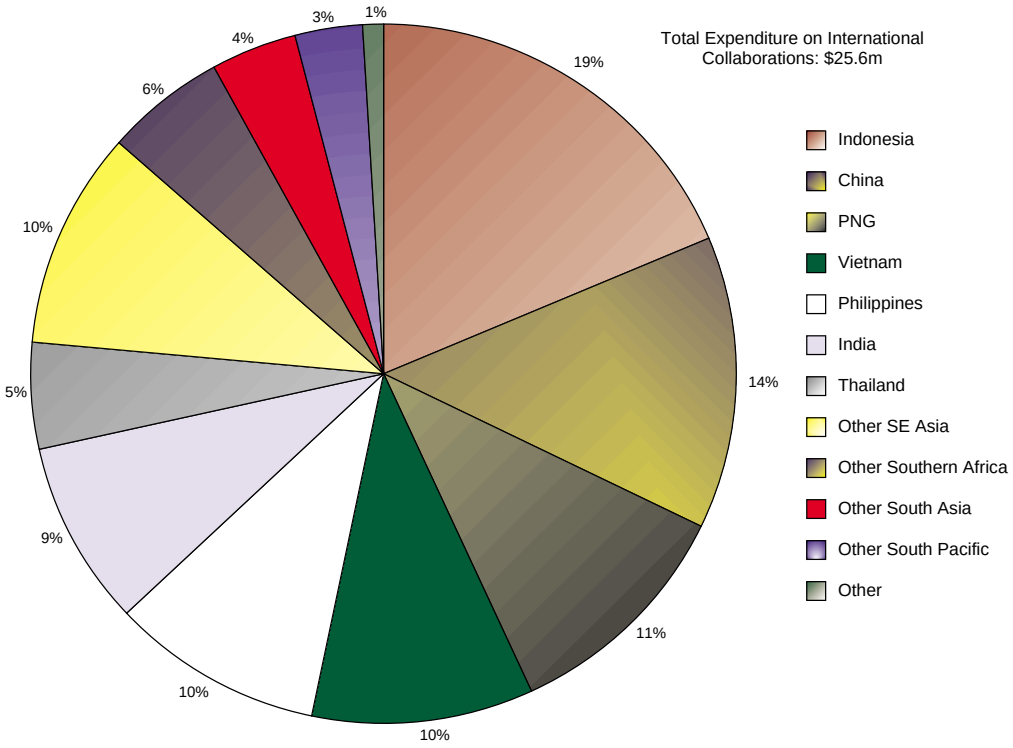
ACIAR – COLLABORATIONS BY COUNTRY



Source: The Allen Consulting Group
Notes:
1. **Other SE Asia**: Malaysia, Laos, Cambodia, East Timor
2. **Other Southern Africa**: Mozambique, South Africa, Zimbabwe
3. **Other South Asia**: Bangladesh, Bhutan, Nepal, Pakistan, Sri Lanka
4. **Other South Pacific**: Kiribati, Vanuatu, Tonga, Samoa, Fiji, Solomon Islands
5. **Other**: Brazil, North Korea

Figure E2

ACIAR – EXPENDITURE BY COUNTRY

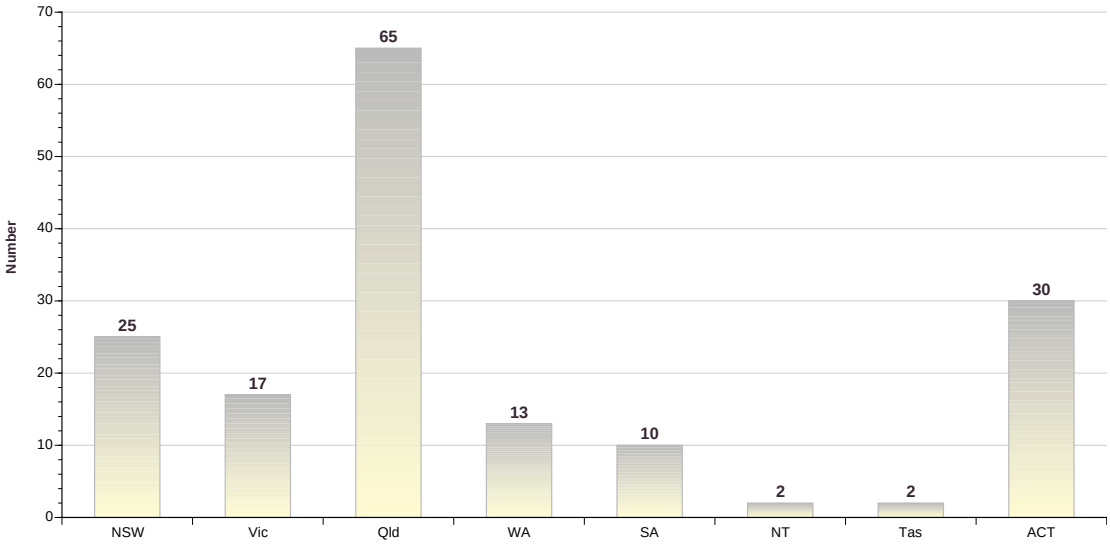


Source: The Allen Consulting Group
Notes: 1. **Other SE Asia**: Malaysia, Laos, Cambodia, East Timor
2. **Other Southern Africa**: Mozambique, South Africa, Zimbabwe
3. **Other South Asia**: Bangladesh, Bhutan, Nepal, Pakistan, Sri Lanka
4. **Other South Pacific**: Kiribati, Vanuatu, Tonga, Samoa, Fiji, Solomon Islands
5. **Other**: Brazil, North Korea

Information relating to the geographical location of Australian participants in ACIAR was aggregated at the State level and is shown in Figure E3 (thus, a breakdown by Metropolitan/Non-Metropolitan is not available). Researchers were clustered mainly in Queensland, the majority whom are located at the University of Queensland or the Queensland Department of Primary Industries.

Figure E3

ACIAR – RESEARCHERS BY GEOGRAPHIC LOCATION



Source: The Allen Consulting Group estimates based on data provided by ACIAR.
Note: ACIAR data does not provide details on whether researcher' geographic location is metropolitan or non-metropolitan.

E3 Communications, Information Technology and the Arts Portfolio

The analysis of this Portfolio is based upon information received on international S&T activities conducted in 2001-2. During this time, the Department of Communications, Information Technology and the Arts (DCITA) did not have any programs specifically designed to foster international S&T cooperation. There were, however, a number of entities within the Portfolio that have a small amount of international S&T activity, including:

- Questacon – The National Science and Technology Centre (NSTC);
- ScreenSound Australia; the Australia Council (OzCo); and
- DCITA's Broadband and Internet Section.

DCITA has responsibility for funding the National ICT Centre of Excellence (NICTA), which has some international S&T activities, however this Centre was not operational in 2001-2 and is therefore not included in this analysis.

E3.1 The Department of Communications, Information Technology and the Arts

DCITA's Broadband and Internet Section directed $15m of Commonwealth funding to the Launceston Broadband Project (LBP) ($10m to Telstra for the B-eLab and $5m to the Tasmanian Electronic Commerce Centre). There may be some scope for international S&T under this sub-program in the research field of Information, Computer and Communication Technologies. An analysis of the LBP could not be performed, however, as the data was provided at an aggregate level. Additionally, funds to Telstra were considered to be 'commercial' and therefore outside the scope of this study.

E3.2 The National Science and Technology Centre

NSTC received $9.6m of Commonwealth funding in 2001-2. NSTC's involvement in science communication and the science centre industry includes international S&T activities, however, the Centre was unable to provide any estimates of Commonwealth expenditure. According to the NSTC Annual Report, visits were made to Hawaii and Oregon in the US, New Zealand, Thailand, Hong Kong and Mexico, with 8 per cent of the Centre's revenue derived from travelling exhibitions and international activities in 2001-2. The purpose of these activities includes, 'bilateral government to government arrangements', 'multilateral fora', 'workshops and missions', 'international collaborative networks/linkages' and 'conferences and societies'. International activities, which may have used Commonwealth funds, include:

- touring exhibitions and presentation of programs (these are particularly active in Asia-Pacific);
- participation and support for multinational networks among science centres, including the Australasian Science and Technology Exhibitors Network, the Asia Pacific Network of Science and Technology Centres, and the Association of Science-Technology Centre (an international network);
- entry into a MOU with the Japanese National Museum of Emerging Science and Innovation, to share resources and information when promoting emerging S&T;

- participation in the 3rd Science Centre World Congress; and
- development of professional training workshops and programs for national science centres and multinational organisations (eg, UNESCO).

E3.3 ScreenSound Australia

As part of the Government's cultural development program, ScreenSound Australia, the National Screen and Sound Archive, collect, store, preserve and make available screen and sound material that is relevant to Australian culture and industry. ScreenSound Australia allocated $50,000 of Commonwealth funds to S&T research in 2001-2, covering two major research fields, Information, Computer and Communications Technology, and Applied Sciences Technologies.

It was not possible for ScreenSound Australia to determine the proportion of these funds expended on international S&T activities. However, ScreenSound's international S&T activities are based upon its internationally recognised expertise in preservation and archival research of audiovisual formats, as well as in software development for audiovisual collection management. ScreenSound co-developed and owns IP for the Merged Audiovisual Information System (MAVIS).

The purpose of ScreenSound Australia's international S&T activities include 'accessing overseas expertise & equipment', 'bilateral organisation to organisation arrangements', 'multilateral fora', 'international collaborative networks/linkages' and 'conferences and societies.' ScreenSound Australia participated in collaborations located in the US, Norway and Germany, and was active in multinational networks through the following organisations and associations: the International Federation of Film Archives, the Association of Moving Image Archivists, the South-East Asia and Pacific Audiovisual Archive Association, ASEAN and UNESCO.

E3.4 The Australia Council

The Australia Council (OzCo) offers a range of grant programs across all art-forms to support Australian artists and arts organisations. In 2001-2, grants with a total value of $40,000 were offered to three early career artists, active in the New Media Arts. The major field of research for these grant was Information, Computer and Communication Technologies and each was located in a different country – Germany, the UK and the US. The purpose of these international activities was equally distributed among 'accessing overseas equipment and expertise', 'researcher to researcher collaborative projects' and 'international collaborative networks/linkages'.

Appendix F

Universities: International S&T Collaborations

The Commonwealth government is the major source of funding for university research in Australia and an important source of both direct and indirect support for international collaborations in science and technology. This Appendix analyses international S&T collaborations at a major research university, the University of New South Wales (UNSW). It was not possible to analyse all universities as information on their international S&T activities is not systematically collected and maintained. Instead, it was decided to develop an illustrative case study of international S&T collaboration for a single university. In this manner it would be possible to gain an understanding of the full range of international S&T collaborations (by partner countries, sources of funding and fields of research) at a public sector university. At the end of this section a estimate of $24m is provided for international S&T collaborations by all universities based on the UNSW analysis.

F1 Introduction – UNSW Case Study

UNSW agreed to participate in this case study and provided information on its international S&T collaborations. Selection of UNSW was based primarily upon its system of information gathering on its international S&T activities, which is exemplary when compared with other universities and public sector research organisations. It was therefore decided that information on international collaborations from the UNSW would be a more reliable and comprehensive representation. The UNSW has a proactive approach to promoting international collaborations, as is illustrated by the existence of its International Programs Office. In addition, the UNSW is a major research organisation with extensive international collaborations across all fields of research, with the exception of Agricultural, Veterinary and Environmental Sciences. However, this analysis departs from the format provided elsewhere in this report because here the dataset includes overseas funding sources that are in addition to Commonwealth funding sources.

Analysis of the UNSW is based upon a dataset of 739 international S&T collaborations current in 2002.[70] This comprises those international activities known to the International Programs Office, including all of those funded through established Commonwealth, University and international programs. However, it is unlikely that the dataset provides a comprehensive representation of those international S&T collaborations funded through departmental, personal or industry sources. The amount of funding for each international S&T collaboration is not included in the dataset. Some information on funding is available (or could be inferred) at program level, but it cannot be obtained across all funding sources (for example, where personal funds are involved or where the source of funds is not identifiable) or at the individual project level.

[70] We thank Prof Mark Wainwright, Deputy Vice Chancellor for agreeing to participating in this study and Dr Ditta Bartels, Director, International Research Programs for her assistance in the assembling and analysis of the data.

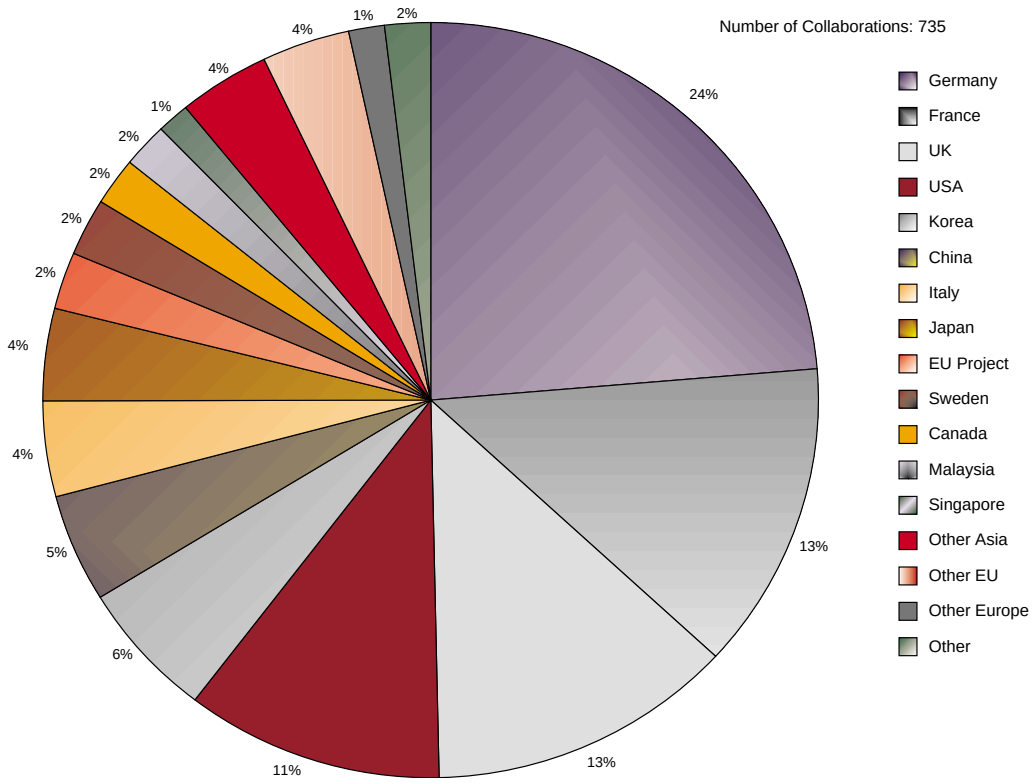
A separate dataset for UNSW international collaborations that received funding in 2002-03 was used to calculate an estimate of expenditure on international S&T activities for all universities. This dataset contained 286 international S&T activities, amounted to $24.1m and excludes activities funded by the ARC and NHMRC. The international S&T activities for all universities are discussed in Chapter 3.

F2 Analysis of S&T activities by Country

Figure F1 shows the mix of 40 countries with which UNSW researchers collaborate. Countries with fewer than 10 collaborations (or representing less than 2 percent) have been listed, according to their rank, in 'other' country groups. It is clear that the majority of collaborations are located in Europe, particularly with members of the EU (EU Project is included separately because participation in 5th and 6th Framework Programs is attributable to the EU rather than to individual member countries). Almost a quarter of all collaborations are with Germany, which may be attributed to the sources of funding available from Germany (see Figure F2). Eleven per cent of collaborations are with the US, and Asian nations Korea, China, Japan, Malaysia and Singapore together comprise 18 per cent of total collaborations. Figure F2 illustrates that the UNSW primarily collaborates with countries traditionally associated with S&T in Australia.

Figure F1

UNSW – COLLABORATIONS BY COUNTRY/ECONOMY



Source: The Allen Consulting Group from UNSW data

Notes:
1. **Other Asia**: India, Hong Kong, Indonesia, Thailand, Maldives, Philippines, PNG, Taiwan
2. **Other EU**: Netherlands, Denmark, Austria, Spain, Belgium, Finland, Ireland
3. **Other Europe**: Switzerland, Greece, Norway, Poland, Romania, Russia
4. **Other**: New Zealand, Brazil, Israel, Iran, Mexico, South Africa

F3 Analysis of International S&T Activities by Sources of Funding

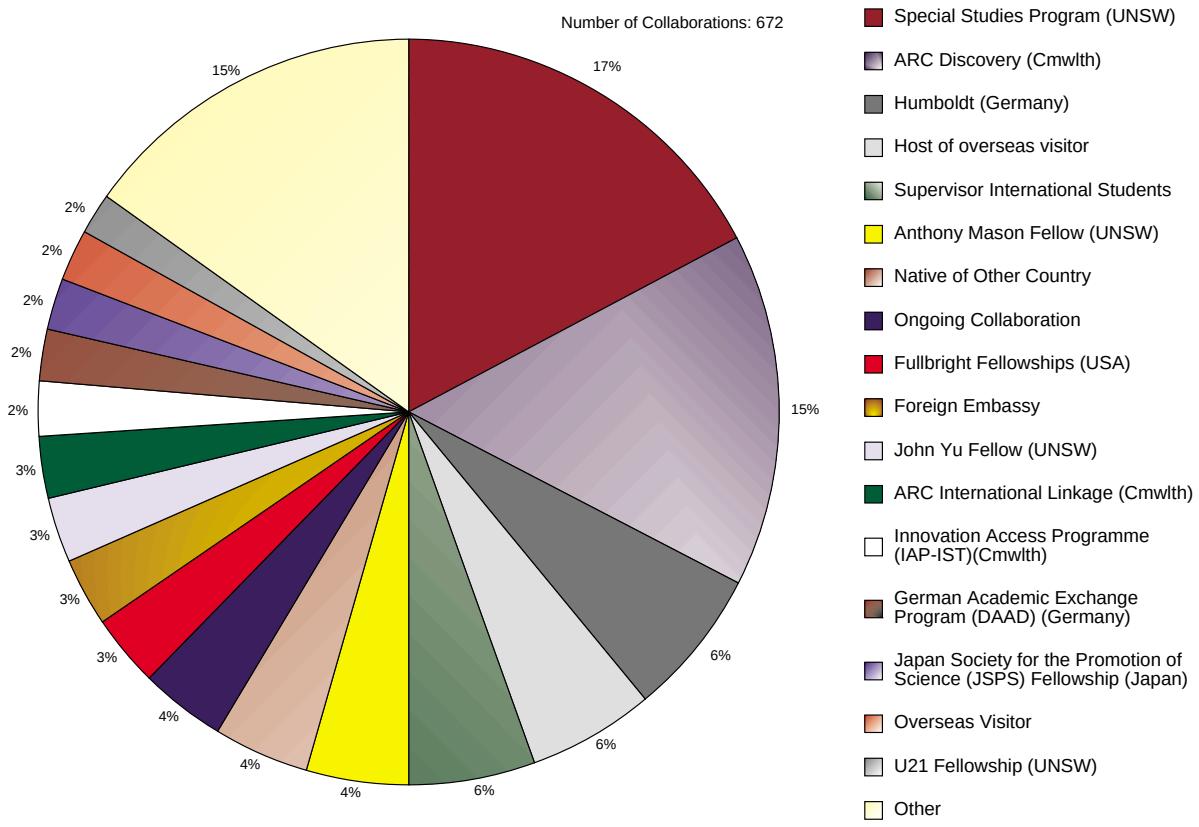
The UNSW dataset demonstrates the use of a variety of funding sources for international collaboration. Figure F2 illustrates funding sources at a disaggregated level, by individual funding program. The source of funds is also given in parentheses to show whether funding programs are from the UNSW, the Commonwealth (Cmwlth) or overseas (OS). The top six groups of funding sources for international S&T are analysed in Figure F3.

A well defined source of funds for international collaboration is the UNSW's Special Studies Program (SSP). This program applies to academics taking their sabbatical leave in an international location. The UNSW promotes international S&T collaborations by using SSP funds to supplement travel and living costs. For a single researcher, SSP assistance amounts up to $6,110 for a 3 month sabbatical and $9,360 for a 6 month sabbatical, in addition to normal salary.

In Figure F2, SSP ranks highest and supports 17 per cent of international collaborations. The Commonwealth ARC Discovery program follows at 15 per cent, followed by the German Humboldt Fellowships funding program at 6 per cent. Other overseas funding programs in Figure F2 include the German Academic Exchange Program (DAAD), the Japan Society for the Promotion of Science Fellowship (JSPS), and Fulbright Fellowships from the US.

Figure F2

UNSW – INTERNATIONAL COLLABORATIONS BY FUNDING PROGRAM



Source: The Allen Consulting Group from UNSW data

Notes:
1. **Other**: NIH, University, FP5, Joint Research Program, KOSEF Postdoctoral Fellowship, NHMRC, AAS, DFG Travel Grant, FP6, Industry, Lynen Fellowship, ARC Irex, AusIndustry, Convenor UNSW/German Teaching Program, Convenor UNSW/German Workshop, DFG Graduate College, Organised joint conference, Research Agreement, Royal Society, Travel Fellowship, AusAID Project, BMBF Travel Award, British Research Council, China Council, CNRS Post Doc, Convenor joint teaching/research program, Convenor UNSW/German Conference, DEST–China Initiative, Federation Fellowship, Former Professor, Fyssen Foundation Prize, Government of Wales, Harvey Prize, IPRS, IRDTA, Joint Publication, Member AusAID Selection Committee, Residency, Royal Society Postdoctoral Fellowship, UNSW Practicum Program, VC Postdoctoral Fellowship
2. Detail in parentheses indicates principal source of funds. Categories without this information are funded from mixed sources.

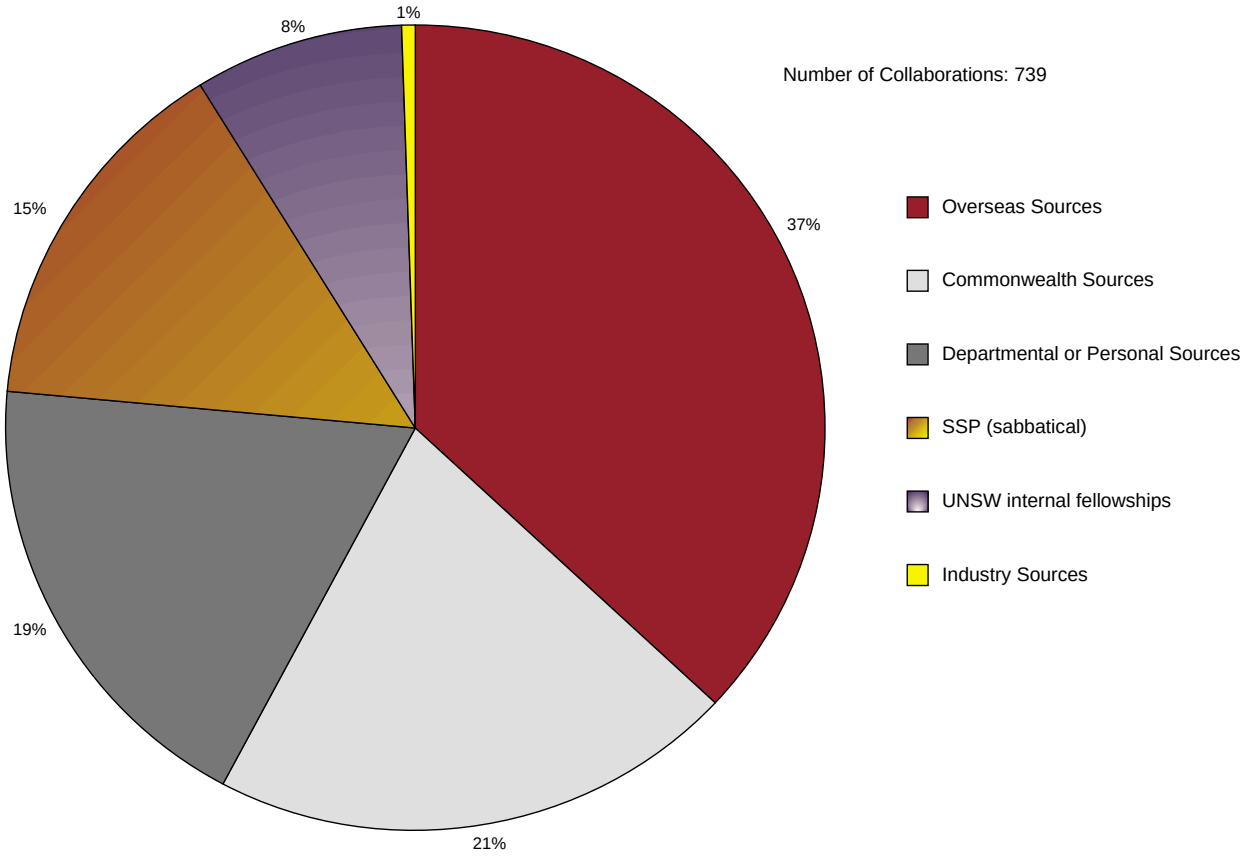
In Figure F3, UNSW collaborations are analysed by source of funds. The largest source of funds is 'Overseas Sources' at 37 per cent. The Commonwealth dominates Australian public sources of funds at 21 per cent (this group includes the Innovation Access Programme, Academy of Science and all ARC programs). Funding from 'Departmental or Personal Sources' ranks third, at 19 per cent, which is somewhat surprising in light of the expectation that this source would be under-represented in the UNSW dataset.

Internal UNSW programs SSP and 'Departmental or Personal Sources' together constitute 34 per cent of funds. UNSW internal fellowships include Anthony Mason Fellowships, John Yu Fellowships, U21 Fellowships and the Vice-Chancellor's Postdoctoral Fellowship. Industry is reported as supporting only one per cent of international collaborations. The latter is unusual as the UNSW has a long record of collaborative research with industry. It therefore seems that collaborations supported by industry are either domestic in their focus or, that UNSW international collaborations with industry are under-reported.

An overall comparison of these two figures suggests that 'Overseas Sources' of funds (which represent 37 per cent of total funds in Figure F3) are comprised of a large number of funding programs (primarily European). In contrast, the UNSW and Commonwealth sources of funds (which include 'Commonwealth Sources', 'SSP' and 'UNSW Internal Fellowships' and when combined represent 44 per cent of total funds) support international collaborations through larger funding programs, such as the SSP and ARC Discovery Grants.

Figure F3

UNSW – INTERNATIONAL COLLABORATIONS BY FUNDING SOURCE



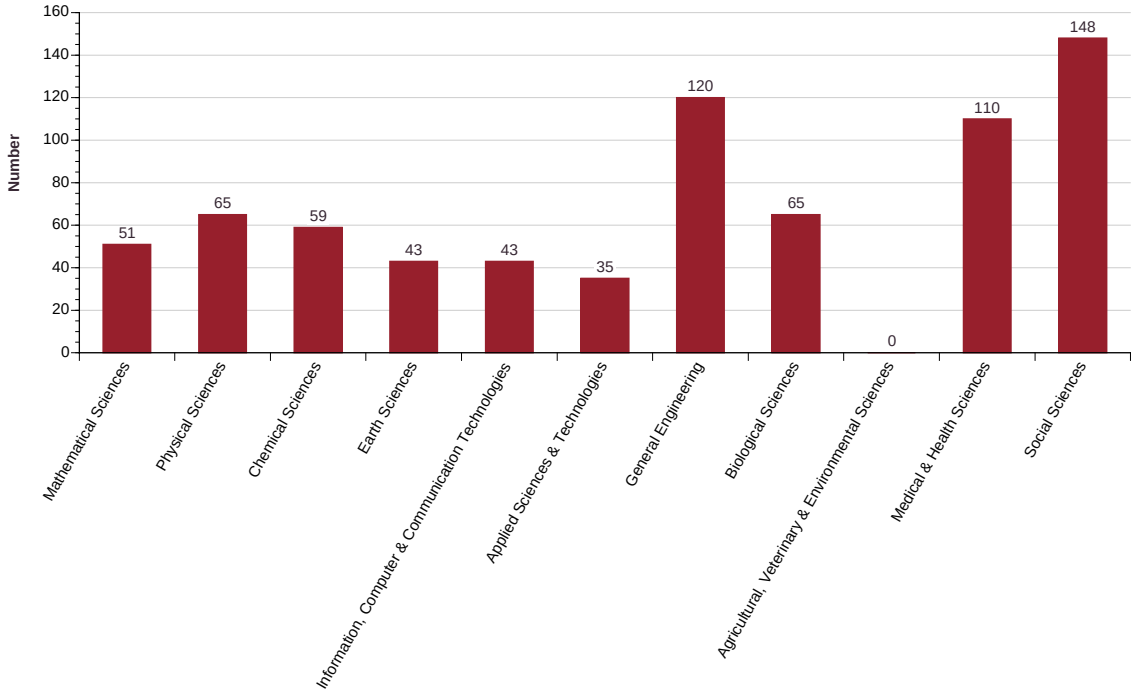
Source: The Allen Consulting Group from UNSW data

F4 Analysis by Field of Research

Figure F4 shows the distribution of UNSW's international collaborations by field of research. There are a relatively large number of collaborations in Social Sciences. General Engineering and Medical and Health Sciences are also relatively high. This distribution reflects the particular areas of specialisation at the UNSW. It also appears that the UNSW is active internationally across a wide range of research fields, with the exception of Agricultural, Veterinary and Environmental Sciences. This distribution is quite different from the overall summary field of research distributions (see Summary Charts in Chapter 8), where Biological Sciences and Agricultural, Veterinary and Environmental Sciences were ranked highest and second highest respectively.

Figure F4

UNSW – INTERNATIONAL COLLABORATIONS BY FIELD OF RESEARCH



Source: The Allen Consulting Group

F5 Case Studies – Profiles of Four UNSW Academics

The following case studies illustrate the broad range of international collaborations undertaken by university-based researchers. As is clear from these descriptions, much of this activity cannot be characterised in such a way that dollar estimates can be provided by each researcher for each case of international collaboration. This reality forms part of the basis for the claim that the actual level of international S&T collaboration far exceeds the estimates made on the basis of grant expenditures.

Professor Maria Skyllas-Kazacos

School of Chemical Engineering and Industrial Chemistry

Professor Maria Skyllas-Kazacos has published over 200 papers in a range of topics in electrochemical engineering, during her successful career at the UNSW. Much of this work has involved the development and commercialisation of a vanadium redox-flow battery, or VRB system. The Redox Flow Cell concept has been known for almost 30 years, with different battery systems being developed and evaluated by various international groups. However, research and development pioneered at the UNSW has shown the greatest commercial potential and many international collaborations have resulted from Professor Skyllas-Kazacos' patents on the vanadium redox-flow battery (VRB). Professor Skyllas-Kazacos also participates in international collaborations that are funded by two Commonwealth research grants:

- an ARC Linkage grant involving Comalco and the University of Auckland; and
- an ARC Discovery grant involving ANSTO, which has links with a Chinese battery manufacturer.

Professor Skyllas-Kazacos' VRB patents were sold by UNSW to the Australia listed company Pinnacle VRB, in 1998. Ongoing commercialisation activities are working to manufacture, sell and install VRB systems in a range of applications around the world. For example, Pinnacle VRB entered into a new licence agreement with Sumitomo Electric Industries (SEI) in 1999. SEI is manufacturing the battery and supplying full systems or vanadium stack components to a range of international customers. Pinnacle VRB is now 70 per cent owned by Canadian company VRB Power. SEI installations of the VRB system include, a VRB Power facility in Utah, US, and the Pinnacle facility on King Island, Tasmania. VRB Power is raising capital for further development of VRB battery stack technology, with work to be done by UNSW and its new R&D commercialisation company.

Professor Skyllas-Kazacos is involved in further commercial development work with UNSW research Centres, the Vanadium Battery Development Group and the Centre for Electrochemical and Minerals Processing. Negotiations with EFuel Technologies, in the UK, are underway to develop a new redox fuel cell using vanadium bromide technology. In this arrangement the UNSW research Centres are developing the electrolyte process and stack technologies, while EFuel are developing the refuelling stations. EFuel has obtained grants from the Engineering and Physical Sciences Research Council in the UK and is currently seeking investors to progress to a large-scale demonstration.

Professor Skyllas-Kazacos is also currently negotiating with a Chinese company that has contacts with a Chinese bus manufacturer. China is interested in developing a vanadium fuel cell powered bus and refuelling station demonstration, in time for the Beijing Olympics. UNSW has held discussions with potential partners (UNSW, Pinnacle VRB and Efuel) on the establishment of a joint venture to commercialise these systems, based upon the success of the China demonstration.

Associate Professor Gail Huon

School of Psychology

Associate Professor Huon's international collaborations are largely the result of her development of a Structural Equations Modelling (SEM) approach to the understanding of eating disorders *Anorexia nervosa* and *Bulimia nervosa*. In Australia, the occurrence of anorexia is increasing and currently affects 1 to 2 per cent of girls aged 11 to 20. It is believed that the incidence of bulimia is similar. SEM is a powerful tool for advancing understanding about these illnesses as it reveals the types and mechanisms by which various factors influence disease. This is particularly true for a preventive and early intervention perspective, taken by Professor Huon, where SEM has demonstrated the emergence of dieting as a precursor to these illnesses.

Professor Huon's international collaborations allow her to implement the SEM approach in different social and cultural contexts. Collaborations in China were facilitated by a UNSW Anthony Mason Fellowship which was used to fund a visit by Professor Huon to China in 1998-99. Another Anthony Mason Fellowship was used to facilitate a reciprocal visit to Australia by Professor Qian Ming Yi, in 2000-01. Subsequently, Professor Huon has accepted an invitation to present her research, as a keynote speaker at the World Congress on Psychiatry, in Beijing, August 2004.

Professor Huon's also has collaborations based in Italy, which were facilitated by the UNSW's Special Studies Program (SSP). Here SSP funds were used to establish and develop collaborations during a four month sabbatical at the University of Padua, in 2000. In partilcular, Professor Huon worked with two prominent psychiatrists, Professor Paolo Santonastaso and Dr Angela Favaro. This collaboration is ongoing, with Professor Huon receiving SSP funding for another three months of research at the University of Padua, late in 2003.

Professor Hans Coster

Co-Director, UNESCO Centre for Membrane Science and Technology

Head of the Department of Biophysics

Professor Hans Coster is a co-director of the UNESCO Centre for Membrane Science Technology and Head of the Department of Biophysics (School of Physics) at UNSW. The Centre for Membrane Science and Technology was originally established in 1988, as a Commonwealth Special Research Centre. It became one of four UNESCO Science Centres worldwide, in 1992, a move that further strengthened its international profile and collaborations.

Professor Coster participates in a diverse array of international collaborations in the field of membrane science and technology, in both programs of research as well as training. These collaborations are based upon electrical impedance spectroscopy, a sophisticated technique for the characterisation of the internal structure of biological and synthetic membranes. This technique was pioneered in the Department of Biophysics in the 1970s and further developed by Professor Coster and his colleagues in the Centre for Membrane Science. In particular, Professor Coster and his group have developed unique, ultra low frequency impedance spectrometers. These spectrometers, used in Professor Coster's international collaborations, can provide structural details of membranes down to the Ängstrom level, which is several orders of magnitude better than similar instruments developed elsewhere in the world. Professor Coster's current collaborations include:

- A 6-month research collaboration at the UNESCO Centre with Dr Jin Soo Park from the Korean Institute of Advanced Science and Technology (KAIST). The Department of Biophysics established this collaboration. Under the collaborative agreement KAIST provides funds for Dr Soo's travel, accommodation and salary, and UNSW meets the costs of laboratory consumables. This collaboration may lead to, 1) further applications of impedance spectroscopy, 2) more collaborations with Korea, and 3) commercial opportunities.
- Fundamental research with Dr Benno Schoenborn from US Los Alamos National Laboratory. This work was developed during two visits to the UNESCO Centre by Dr Schoenborn, each of 3-months duration. Dr Schoenborn has subsequently become a Visiting Professor at UNSW.
- A new collaboration with Montford University in the UK, which will use impedance spectroscopy to study lipid membranes and liposomes for drug delivery.
- A further application of impedance spectroscopy in the development of new types of biosensors, for example, biohazard detectors. UNSW and Los Alamos National Laboratory are jointly pursuing the potential for further development of this application with the US Department of Energy (DOE). The DOE has an interest in biohazard detector research.
- The German company, Evotek Technologies, is involved in the development of drug discovery technologies, instruments and services. The company is collaborating with Professor Coster to use impedance spectroscopy to enhance the scope and performance their instruments. If successful, this collaboration could develop another application for impedance spectroscopy.
- An ongoing collaboration is in place with the Prince of Songkla University, in Thailand. The UNESCO Centre played a pivotal role in establishing the Centre for Biophysics and Membrane Science at the Prince of Songkla University and direct involvement in collaborative research and training continues. To date, the UNSW has hosted three Thai PhD students associated with this collaboration.

Professor Coster is assisting in developing a postgraduate training programme (fee-paying Masters by coursework) with the National Biodynamics Centre in Burcharest, Romania.

Professor John W. V. Storey

Head of the School of Physics

Professor John WV Storey's research interests include, Infrared and Millimeter astronomy and Antarctic astronomy, with an additional active interest in energy efficient and environmentally friendly vehicles. Professor Storey's interest in astronomy includes research on star formation, planetary nebulae and active galactic nuclei. The high Antarctic plateau contains the world's best observing sites for infrared and sub-millimeter astronomy. The high Antarctic plateau is cold, high and dry, conditions that are vital attributes for an observatory site. Professor Storey is particularly interested in the development of innovative instrumentation to be located at the high Antarctic plateau. Such instruments will facilitate studies of astronomical regions of interest to Professor Storey (for example, a survey of massive star forming regions in our Galaxy). The majority of Professor Storey's international collaborations relate to his research interest in Antarctic astronomy and instrumentation, as outlined below.

The Joint Australian Centre for Astrophysical Research in Antarctica (JACARA) was formed to facilitate Australian participation in the development of Antarctic astronomy. In particular, JACARA is assessing the scientific potential of the high Antarctic plateau as a location for an Antarctic Observatory, and is developing an Automated Astrophysical Site Testing Observatory (AASTO) for this location. Professor Storey is a member of the Australian Working Group for Antarctic Astronomy, which provides advice to JACARA. This research program has strong collaborative ties with the US Centre for Astrophysical Research in Antarctica (CARA), a consortium of US universities managed by Yerkes Observatory of the University of Chicago.

Apart from his role in the Australian Working Group, Professor Storey's research is directly involved in determining the suitability of the high Antarctic plateau for a wide range of astronomical observations and in developing instruments to withstand the harsh Antarctic environmental conditions. International collaborations relating to this research are located in Germany, France, US and Italy. During the past year, Professor Storey's international collaborations incorporated visits to Germany, US, Italy, the Australian Antarctic Territory and the South Pole.

F6 Expenditure on International S&T Activities for All Universities

The overview of the UNSW case study and the descriptions of the activities for the four researchers provided above form the basis for estimating the international collaborations for all universities. Since there is no systematic information on the international S&T activities and expenditures of universities, there is little recourse but to estimate at this time. The method for estimating the expenditure on international S&T collaborations for all universities is provided below.

As described in this Appendix, those UNSW international S&T activities known to the University's International Research Programs Office involved an estimated expenditure of $24.1m in 2002-3. This expenditure represents approximately 12 per cent of all UNSW expenditure on research in 2002-3. There are 17 Australian universities, including the UNSW, which can be classified as research intensive (Footnote Research intensive universities are those where National Competitive Grants per academic researcher were more than $10,000 in 2001). It has been assumed that these universities spend a similar percentage of their total research expenditure on international activities. On that basis, it can be estimated that the total international expenditure from these universities was approximately $218m in 2002-3.

For the remaining Australian universities, it has been assumed that the rate of expenditure on international S&T activities is half that of the research-intensive universities. On this basis, the total international expenditure by Australian universities in 2002-3 would have been $305m. However, some of these funds have been provided through ARC, NHMRC and DEST-IAP. In the case of UNSW, nearly 20 per cent of international activity funding was provided from these sources. Excluding ARC, NHMRC and IAP–IST, university expenditure on international activities in 2002-3 was therefore $244m.

This methodology has a number of limitations. The UNSW figure of $24.8 million represents only 286 of the currently active links. While these are probably most of the well-funded collaborations, it is estimated that there are about another 1,000 currently active collaborations. As a consequence, the $24.8m is an underestimate of the total international S&T expenditure. On the other hand, UNSW may be at the high end of a scale of intensity in international collaborations, even for research-intensive universities. If this is the case, the effect would be to overestimate the total S&T expenditure. Thus, it is not known whether the estimate of $244m for university expenditure on international S&T is too high or too low.

Of the $244m total for universities, it is estimated that 10 per cent can be attributed to block funding by the Commonwealth.

Appendix G

The US Committee on International Science, Engineering and Technology

The activities of the US NSTC's Committee on International Science, Engineering and Technology (CISET) are directed towards three broad, complementary goals:

- to identify and coordinate international cooperation that can strengthen the domestic S&T enterprise and promote US economic competitiveness and national security;
- to utilize American leadership in science and technology to address global issues and to support the post-Cold War tenets of US foreign policy - promoting democracy, maintaining peace, and fostering economic growth and sustainable development; and
- to coordinate the international aspects of Federal R&D funding across the Federal agencies.

CISET's goals include to:

- promote long-term, effective international cooperation, particularly for large-scale, complex S&T programs and global issues;
- increase emphasis on anticipatory research — R&D programs designed to prevent problems in health, the environment, population, crime and the proliferation of weapons of mass destruction; and
- integrate environmental objectives into other goals in programs to foster advances in industrial technology, transportation, natural resources utilization, and energy and food and fibre.

In the recent past, CISET priorities have included the following:

- a Healthy Educated Citizenry;
- job Creation and Economic Growth;
- world Leadership in Science, Mathematics and Engineering;
- improved Environmental Quality;
- harnessing Information Technology; and
- enhanced National Security.

CISET members represent all Federal agencies and departments that conduct, or are affected by, federally funded R&D programs. Most of the work of the Committee is done in working group meetings that are open to all member agencies, and aim to produce consensus results. Any CISET member organisation can raise issues for Committee consideration, subject to the agreement of the co-chairs. If a high-level policy decision is required, or if interagency consensus cannot be reached within CISET, any issue can be elevated for consideration by the NSTC. In accord with the principles of the NSTC, working groups can call upon the expertise of individuals and organisations from outside the government.

The role of CISET is to review the wide range of bilateral and multilateral international scientific programs that agencies undertake to support their missions, and to identify opportunities for international cooperation and interagency coordination in response to new needs and opportunities, without interfering with, or duplicating, existing interagency (or international) programs and procedures. In addition, CISET serves as a forum for establishing government policy on specific problems and issues that arise in the international S&T arena.

In pursuing the three goals defined in the previous section, CISET's concrete task is to identify or design the most effective forms of cooperation in the increasingly global context of US science and technology efforts. International cooperation is of increasing importance due to:

- strong pressures on science budgets throughout the world that require a pooling of scarce resources;
- the ever-increasing number of areas in which the frontiers of knowledge can be significantly advanced, and the resulting expansion in the numbers of promising opportunities for cooperative R&D;
- scientific imperatives towards large, complex projects in many fields of science;
- increasing levels of scientific and technological excellence outside the U.S, particularly in the numbers of talented and highly-trained experts in a variety of fields;
- new opportunities for post-Cold War cooperation with former adversaries;
- dramatic acceleration in the use of high-speed computer networks for data exchange and for real-time interactions among scientists and engineers; and
- increased global threats that require an international S&T effort, for example, HIV/AIDS and other new and re-emerging diseases.

CISET provides a useful model for Australia in terms of coordinating international S&T activities across government.

Appendix H

Australia's S&T Agreements

International science and technology arrangements for which the Department of Education, Science and Training has responsibility are listed in Table H1. In addition, agreements currently being negotiated and developed include ones with South Africa; Indonesia, the US and Argentina.

Table H1

DEST INTERNATIONAL S&T AGREEMENTS

Country/Economy	Agreements
Brazil	MOU between the Ministry of Science and Technology of the Federative Republic of Brazil and the Department of Industry, Science and Resources.
Chile	MOU between the Department of Industry, Science and Resources and the National Commission for Scientific and Technological Research (CONICYT) of Chile.
China	Agreement between the Government of Australia and the Government of the People's Republic of China on Cooperation in S&T.
	MOU under the agreement between the Government of Australia and the Government of the Peoples Republic of China on cooperation in S&T.
	MOU between the Department of Industry, Science and Resources and the Ministry of Science and Technology of the People's Republic of China on the Establishment of a special fund for Scientific and Technological Cooperation (Expires 1 July 2005).
European Community	Cooperation agreement between the Government of Australia and the European Organisation for Nuclear Research (CERN) concerning the further development of scientific and technical cooperation in research projects at CERN.
	Agreement relating to Scientific and Technical Cooperation between Australian and the European Community (amended 9 December 1999).
France	Scientific and Technological agreement between the Government of Australia and the Government of the French Republic.
	Arrangement for cooperation between the Australian Department of Industry, Technology and Commerce and the Republic of France's Department of Research and Technology in Marine Science and Technology.
Germany	Agreement between Australia and the Federal Republic of Germany on scientific and technological cooperation.
Italy	Joint Declaration for cooperation in scientific research and technology between the Government of Australia and the Government of the Italian Republic.
India	Agreement between the Government of Australia and the Government of the Republic of India on Cooperation in the fields of science and technology.
	Special arrangement between the Department of Industry, Technology and Commerce, Australia and the Council of Scientific and Industrial Research, India for cooperation in science and technology.
	MOU between the Australian Department of Industry, Science and Tourism and the Indian Department of Science and Technology.
Indonesia	MOU between the Australian Department of Industry, Science and Technology and the Indonesian Agency for the Assessment and Application of Technology concerning collaboration in science and technology - 29 May 1995 (expired 29 May 2000, extended indefinitely by an exchange of letters).
Israel	MOU between the Department of Science of Australia and the Ministry of Science and Development of the State of Israel on cooperation in the fields of science and technology.
Japan	Agreement between Australia and Japan on cooperation in research and development in science and technology. An exchange of notes extended the Agreement indefinitely.
Korea	MOU between the Government of Australia and the Government of the Republic of Korea on Scientific and Technological Cooperation.
	Arrangement on Industry and Technology Cooperation between the Department of Industry, Science and Tourism, Australia and the Ministry of Trade, Industry and Energy, Republic of Korea.
	Agreement between the Government of Australia and the Government of the Republic of Korea on Scientific and Technological Cooperation.
	Arrangement between the Department of Industry, Science and Resources of Australia and the Ministry of Commerce, Industry and Energy of the Republic of Korea for the Pilot Australia-Korea Industrial Technology Cooperation Fund - 1 January 2001 (expires 1 January 2004).

Country/Economy	Agreements
/Malaysia	MOU between the Government of Australia and the Government of Malaysia concerning Scientific and Technological Cooperation.
Mexico	Basic Agreement between the Government of Australia and the Government of the United Mexican States on Scientific and Technical Cooperation.
The Netherlands	Arrangement for Industrial and Technological Cooperation between the Government of Australia and the Government on the Netherlands.
Philippines	MOU between the Government of Australia and the Government of the Philippines concerning Scientific and Technological Cooperation.
Russian Federation	Agreement between Australia and the Union of Soviet Socialist Republics on Scientific-Technical Cooperation.
Taiwan	MOU on Scientific Cooperation between the Taipei Economic and Cultural Office, Canberra and the Australian Commerce and Industry Office, Taipei.
Thailand	MOU between the Government of Australia and the Government of Thailand concerning Scientific and Technological Cooperation.
UK	Partners in Innovation: Arrangement between the British Council in Australia and the Department of Industry, Science and Tourism.
Vietnam	MOU between the Government of Australia and the Government of the Socialist Republic of Vietnam on Scientific and Technological Cooperation.
Multilateral	MOU for the Global Biodiversity Information Facility.

Source: DEST

Appendix I

Australia's National Research Priorities[71]

Backing Australia's Ability[72] committed $3 billion to science and innovation and flagged the need for these vital areas to focus on Australia's present or likely competitive advantages.

National research priorities were developed in two stages. The first stage was an inclusive consultative process that spanned across our cities and regional and rural Australia. This involved around 800 participants to determine a proposed framework for setting priorities. One of the results was the emergence of a general consensus in the community on the value of setting priorities.

The second stage was the development of a short-list of priorities for Government consideration, led by an expert committee chaired by Dr Jim Peacock, President of the Australian Academy of Science. The committee based its short-list on the merits of suggestions in more than 180 public submissions. In its final consideration of national research priorities, the Government then arrived at four 'whole of government' themes of critical long-term importance to Australia:

• An Environmentally Sustainable Australia

• Promoting and Maintaining Good Health

• Frontier Technologies for Building and Transforming Australian Industries

• Safeguarding Australia

Each of the four themes is described below along with the priority goals that support the national research priorities.

An Environmentally Sustainable Australia.

This priority deals with the way we use our land, water, mineral and energy resources. Making the most of our natural resources in the long term will depend on a better understanding of the environment and on the application of new technologies to natural resource industries. We need to develop more sustainable water management practices and protect and remediate our fragile soils. Significant opportunities lie in managing our unique flora and fauna, in developing our deep earth resources, and in developing cleaner and more efficient energy technologies.

Transforming the way we use our land, water, mineral and energy resources through a better understanding of environmental systems and using new technologies, involves the following six priority goals:

1. **Water – a critical resource**. Ways of using less water in agriculture and other industries, providing increased protection of rivers and groundwater and the re-use of urban and industrial waste waters.

[71] This section quotes directly from the DEST websites that cover the National Research Priorities. See - www.dest.gov.au/priorities

[72] Commonwealth of Australia, 2001, *Backing Australia's Ability–an innovation action plan for the future*. See: http://backingaus.innovation.gov.au/statement/pm_speech.htm

2. **Transforming existing industries.** New technologies for resource-based industries to deliver substantial increases in national wealth by reducing environmental impacts on land and sea.

3. **Overcoming soil loss, salinity and acidity.** Identifying causes and solutions to land degradation using a multidisciplinary approach (examples include incorporating hydrology, geology, biology and climatology) to restore land surfaces.

4. **Reducing and capturing emissions in transport and energy generation.** Alternative transport technologies and clean combustion and efficient new power generation systems and the capturing and sequestration of carbon dioxide.

5. **Sustainable use of Australia's biodiversity.** Managing and protecting Australia's terrestrial and marine biodiversity to develop long term use of ecosystem goods and services ranging from fisheries to ecotourism.

6. **Developing deep earth resources.** Smart high-technology exploration methodologies, including imaging and mapping the deep earth and ocean floors and novel, efficient ways of commodity extraction and processing (examples include minerals, oil and gas).

Promoting and Maintaining Good Health.

This priority promotes good health and preventive health care, particularly among young and older Australians. It is about promoting the healthy development of young Australians, developing better social and medical strategies to ensure that older Australians enjoy healthy and productive lives, and encouraging all Australians to adopt healthier attitudes, habits and lifestyles.

Promoting good health and preventing disease, particularly among young and older Australians, involves the following three priority goals:

1. **A healthy start to life**. Reducing the impact of genetic, social and environmental factors predisposing infants and children to ill health and reducing their life potential.

2. **Ageing well, ageing productively**. Developing new and better social and medical strategies to reduce mental and physical degeneration based on greater knowledge and understanding of the causes of disease and degeneration of mind and body.

3. **Preventive healthcare**. New evidence-based strategies to promote healthy attitudes, habits and lifestyles and to develop new health-promoting foods and nutraceuticals.

Frontier Technologies for Building and Transforming Australian Industries.

This priority embraces areas where there have been, and continue to be, rapid advances in basic research that are expected to lead to new industries. It recognises that critical capabilities such as nanotechnology and ICT research and research training need to be expanded and enhanced.

Stimulating the growth of world-class Australian industries using innovative technologies developed from cutting-edge research, involves the following four priority goals:

1. **Breakthrough science.** Better understanding of the fundamental processes that will advance knowledge and develop technological innovations (examples include bio-informatics, nano-assembly, quantum computing and geo-informatics).

2. **Frontier technologies.** Enhanced capacity in frontier technologies to power world-class industries of the future and building on Australia's strengths in research and innovation (examples include nanotechnology, biotechnology, ICT, photonics, genomics/phenomics, and complex systems).

3. **Advanced materials.** Advanced materials for applications in construction, communications, transport, agriculture and medicine (examples include ceramics, organics, biomaterials, smart materials and fabrics, composites, polymers, and light metals).

4. **Smart information use.** Improved data management for existing and new business applications and creative applications for digital technologies (examples include e-finance, multimedia, content generation and imaging).

Safeguarding Australia.

This priority focuses on a range of research relevant to protecting Australia from terrorism, crime, invasive diseases and pests and threats to our critical infrastructure. Recent events have highlighted the critical importance of this issue for Australia. The heightened interest in personal and electronic security across the world also provides an opportunity for Australian solutions.

Safeguarding Australia from terrorism, crime, invasive diseases and pests, and securing our infrastructure, particularly with respect to our digital systems, involves the following four priority goals:

1. **Critical infrastructure.** Protecting Australia's critical infrastructure including our financial, energy, computing and transport systems.

2. **Protecting Australia from invasive diseases and pests.** Counteract the impact of invasive species through the application of new technologies and by integrating approaches across agencies and jurisdictions.

3. **Protecting Australia from terrorism and crime.** By promoting a healthy and diverse research and development system that supports core competencies in modern and rapid identification techniques.

4. **Transformational defence technologies.** Transform military operations for the defence of Australia by providing superior technologies, better information and improved ways of operation.

Appendix J

Worksheet Templates

<Agency Name> Worksheet

International Science and Technology Activities

Table 1 - Projects and Collaborations

<Program Name>

Agency Project ID or Short Description	*Source of Funds within Commonwealth (ex. EA, CSIRO, ARC, etc)*	*Grant Recipient Organisation (university name, CSIRO etc.)*	*Expenditure on S&T (2001-02 Fiscal Year)*		*Foreign Principal? [3] (1 or blank)*	*Collaborating Country or Entity (EU, OECD, etc)*	*Other Countries….*	*Main Field of Research [5]*	*Number of Early Career Researchers [6]*
			Total Commonwealth Expenditure[1]	International Portion[2]					
Total									

NOTES

1 Show only Commonwealth share; exclude private sector and producer and state shares.

2 If there is a foreign principal, count 100% of expenditure as international.

If there are overseas partners, estimate international share or please call Brenda Dyack to discuss 02 6230-0185.

3 Is a major foreign partner included?

4 Add colums to show each collaborating country

5 See attached ASRC Field of Research Classifications .

6 Researchers within 5 years of graduation.

ASRC CODES

1. Mathematical Sciences
2. Physical Sciences
3. Chemical Sciences
4. Earth Sciences
5. Information, Computer and Communication Technologies
6. Applied Sciences and Technologies
7. General Engineering
8. Biological Sciences
9. Agricultural Sciences
10. Medical and Health Sciences
11. Social Sciences

<Agency Name> Worksheet

International Science and Technology Activities

Table 2 - Detailed Geographic Location Of Researchers

<Program Name>

Agency Project ID or Short Description	***Number of Researchers by Geographic Location ** (see codes below)***														
	NSW		***VIC***		***QLD***		***WA***		***SA***		***NT***		***TAS***		***ACT***
	Code*	***No.***	***Code****	***No.***	***Code****	***No.***	***Code****	***No.***	***Code****	***No.***	***Code****	***No.***	***Code****	***No.***	***No.***

**** See attached geographic locations.***

***** State Codes - Use more than one row if there is more than one location within a state or territory.***

NSW
A. Sydney
B. Newcastle/Central Coast
C. Wollongong/Illawarra
D. N.E./N. Coast/N.W.
E. Central West (Bathurst, Orange, Broken Hill)
F. Southern/Riverina (Wagga, Albury)

VIC
A. Melbourne
B. Geelong
C. Ballarat
D. Bendigo
E. North East (Shepparton/Wodonga/Mildura)
F. Gippsland

Queensland
A. Brisbane
B. Gold Coast
C. Sunshine Coast
D. Darling Downs/S.W.
E. Central Queensland
F. North Queensland

WA
A. Perth
B. West
C. Central
D. North
E. South
F. Interior (Kalgoolie)

SA
A. Adelaide
B. East (Barossa, Mt Gambier)
C. Central (Whyalla)
E. Northern/Western

Northern Territory
A. Darwin
B. North
C. Central (Alice Springs)

Tasmania
A. Hobart
B. Launceston

<Agency Name> Worksheet

International Science and Technology Activities

Table 3 - Purpose and Type of Project

<Program Name>

Agency Project ID or Short Description	***Purpose****											
	1. Accessing overseas equipment and expertise	2. Accessing large scale facilities	3. Researcher to researcher collaborative projects	4. Bilateral government to government arrangements	5. Bilateral organisation to organisation arrangements	6. Multilateral fora	7. Fellowships and awards	8. Workshops and missions	9. International S&T Programs	10. Exchanges	11. International collaborative networks/ linkages	12. Conferences and societies
Total												

***** Enter a "1" for each purpose that applies.***