ATSE

Supplementary Submission on International Research Collaboration

by

The Australian Academy of Technological Sciences and Engineering

6 April 2010

It is hard to overstate the importance of international cooperation to the process of innovation. Finding out what others are doing, and why, is a spur to one's own thinking about development needs.

Talking to international colleagues, on a face-to-face basis, is a sine qua non to get a real feel for where science and engineering programs in each country are focusing and understanding exactly where they are putting their stakes in the ground for the future development of their economies. If the money spent on research, wherever it is done, does not eventually reach the marketplace then we are all losers. And by engaging in discussion about the specific areas where our competitors (which is the way to view them) are focusing is more than helpful; we are actually competing for the same markets with our allies and knowing what they think is vital.

And, let's face it, breakthroughs in science and engineering are the most likely ways by which innovation occurs, wherein ideas from the bench are transferred into the marketplace. This begets economic growth which, in turn, allows us to produce goods and services, once considered luxuries.

Dr Peter Farrell AM FTSE

1. The Economic Imperative

There is a large body of science undertaken in the world that targets innovation. Various studies have indicated that the higher the quality of science (as measured by peer review) the greater the chance of practical applications in the market place.

The focusing question is therefore, not just "Is international collaboration a good thing to help Australia tap into 98 per cent of the science and technology research done elsewhere?" It should be: "Does international collaboration lead to a raising of the level of our science and technology research in terms of peer reviewed quality?"

The answer is demonstrably-"Yes".

A study of two years of all of US patents looked at whether there was a relationship between the quality (as measured by peer review) of the underlying science and the resulting performance (ie the market place). The relation was positive and clear cut.

CSIRO is also a good case study in Australia. It has heavily focused on international collaboration and applied research. Using citation rankings over the 10-year period from January 1999 to October 2009 from the ISI Web of Knowledge, Essential Science Indicators (Thomson, 2010), CSIRO rated 205th of 4226 institutes for citations in all fields of study. However, it was in the top 10 per cent for four of the 20 topic fields and impressively is the only Australian research institution to be ranked in the top 10 in the world for three fields (ie: Plant and Animal Sciences, Environment/Ecology and Agricultural Sciences).

How do you get to be in the top 10 in the world? CSIRO runs over 1000 international research collaborations each year, working with leading scientific organisation in more than 70 countries, with a range of partners and clients, including foreign governments, small companies, large multinationals and international foundations.

CSIRO has also joined, with eight other leading international science organisations, to form the Global Research Alliance. This alliance leverages combined capabilities to target the current United Nations' Millennium Goals in water, energy, health, transport and the digital divide. CSIRO is the only Australian member of this Alliance.

In our earlier (February 2010) submission, ATSE pointed out that quality- as measured by citation impact- is significantly higher for Australian researchers who collaborate internationally as opposed to those not collaborating.

Given the compelling evidence that economic impact is linked to the quality of research, and that quality research comes with global collaboration, one can justifiably argue that we should be spending more of our precious research dollars on international collaboration.

2. Enhanced impact of international Linkages

As noted in our earlier submission, the conversion of scientific research and ideas into real world applications is the ultimate aim in supporting and stimulating the science and technology sector in Australia. Improving the linkages between the various components

in the innovation system, both nationally and internationally and through international collaboration, serves to accelerate practical outcomes.

A good example of this is the Government's recent extension of the Australia-India Strategic Research Fund which raises the bar in terms of maximising benefit from international collaboration. The new fund integrates end users into the process, is more cognisant of critical mass and focuses flagship projects into agreed priority areas that have "triple-bottom-line" impact in both countries. Importantly, it retains the key element of requiring the research to be of the highest quality, recognising this is a key to success.

The ongoing support of international research collaboration is particularly needed in Australia as we work to address our poor performance to date in research to "big-business" links. While we are in the top 10 of OECD member countries for SMEs collaborating in innovation with research in the higher education, this innovation is only a minor contributor to Australia's triple bottom line. Through strategic research linkages to those countries with successful innovation investments and linkages to global big business, Australia can benefit from significant industry investment in our research innovations.

> ***"If the money spent on research, wherever it is done, does not eventually reach the marketplace then we are all losers."***

3. Conclusion

It is hard to overstate the importance of international collaboration in building quality research and innovation in Australia and its positive contribution to Australia' economic wellbeing. A number of case studies illustrating the economic benefits flowing from international collaboration in research are at Appendix I.

ATSE supports international collaboration as a most efficient and effective way of achieving high quality research targeted at the practical outcomes of transferring science and technology into real world applications.

ATTACHMENTS

Appendix I outlines seven case studies on international collaboration and how such collaboration adds to Australia's "triple-bottom-line".

Appendix II provides a number of views and experiences of international collaborative research for some of our Fellows.

APPENDIX I

International Collaboration Adds to Australia's "Triple-Bottom-Line": Seven Case Studies.

Case 1

The Wark Institute currently comprises 160 or so staff and research students representing 39 separate nationalities. We have extensive international research collaboration with both industrial companies and other research institutions/laboratories/centres in Europe, South Africa, South America, North America and Asia. In all areas of research, and from The Wark's point of view, it is self-evident that international cooperation can yield major benefits. This occurs in the following ways:

1. Recruitment of the very brightest international graduate students to undertake PhD studies.
2. Recruitment of the very best staff at junior and senior levels.
3. Access to expertise and facilities which are unavailable in Australia.
4. The sharing of ideas and concepts.

Some specific examples of success:

- ✓ One area of the strength in the Wark deals with our ability to solve complex problems in the minerals industry, specifically involving pulp chemistry upon surface interactions which take place between various minerals. Over the last decade or more, we have cooperated extensively with industry throughout Australia, the US, Canada and South Africa, in a project through AMIRA International. Universities in Canada, (e.g. McGill); South America, (University of Sao Paulo); and South Africa (University of Cape Town), have been involved in this research. Apart from the normal outputs of high quality PhD theses and publications in highly ranked journals, the return to industry from this research has been valued by RMD-STEM as returning $22 to the companies for each $1 of research money spent. This is an excellent example of where international cooperation has been mutually beneficial.

- ✓ A second example is our work on bioresponsive surfaces. Our expertise and understanding in how molecules adsorb at the surface of biologically significant interfaces is very important in areas as diverse as contact lens fouling and medical implants. Through work conducted in the Wark Institute, and collaboration with ETH (the Swiss Federal Institute of Technology) we have identified particular bio active molecules which have remarkable ability to reduce infection when suitably coated implants are placed in the human body. This work has now progressed to the stage where further sponsorship is in part being funded through a direct contract from a Swiss company which has an interest in substantial international sales in the area. The research could not have been conducted without the splendid reciprocal cooperation between the Wark at University of SA and ETH.

I might add that on at least six occasions now we have been frustrated in our attempts to link with EU teams because of the dearth of Australian Federal Government funding. I should also like to point out, as member of the ARC Council that the ARC would like to see a substantial injection of funds into the international collaboration arena. The amount currently available is pitiful. Joint centres funded through the Australian Government with overseas countries would be ideal.

Professor John Ralston AO FAA FTSE
Laureate Professor of Physical Chemistry and Mineral Processing
and Director, Ian Wark Research Institute, University of South Australia

Case 2

Just two examples of international collaboration that has affected Australia's triple bottom line:

1. *Through the University of Melbourne, the Particulate Fluids Processing Centre and later the CO2CRC I have had a long standing relationship with Tsinghua University in China where we have exchanged students supported through a range of Australian and Chinese schemes. Two years ago we had a young Postdoctoral Fellow spend one year with us. He worked on improvements in techniques for the capture and separation of CO_2 from combustion gases to*

reduce greenhouse gases. At the time we were looking at ways to reduce the cost of contacting the gas and solvents as cost is a major impediment to implantation of this technology. His supervisor in China had developed a new column "internal" for use in an alternative application. While he was here we tried this new internal in our laboratory equipment which showed considerable success, so much so that we now are using it in Australia's only coal gasification CO_2 Capture program on pilot scale. This has shown to be very successful and will reduce the cost of application of this technology in generation of power plant significantly.

2. *Collaboration between ourselves and engineers in Israel and Germany on the design and construction of solvent extraction equipment in the mining industry has ensured that the Australian mining industry has been at the forefront of developments in this area and so retained their competitive advantage. An example of this has been in the uranium industry, where BHP at Olympic Dam was the first to use column contactors to extract uranium, (previous technology was mixer settlers). This new technology reduced solvent inventory and solvent losses and is more reliable delivering targetable benefits to the mining industry. Now all of the new uranium and the next nickel/cobalt process will be built with this technology.*

Professor G W Stevens
Director, Particulate Fluids Processing Centre (ARC Special Research Centre)
Department of Chemical & Biomolecular Engineering,The University of Melbourne

Case 3.

Australia's engagement in international agricultural research and education (through AusAID, ACIAR, universities, government departments, Crawford Fund, ATSE and NGOs) has imparted knowledge and skills and delivered sustainable technologies for local conditions. The above collaboration has also immensely benefitted Australia. Australia's international collaboration in agricultural research and education has had the following broad categories of output/outcomes:

- new technologies or practical approaches to dealing with particular problems or issues, designed to be applied at the farm or process level;
- new scientific knowledge or basic understanding (pure or basic science) of the phenomena or social institutions that affect agriculture, designed as input into further research process, ultimately to help in the future development of practical approaches at the farm or processing level;
- the development of knowledge, models and frameworks to aid policymakers or broad-level decision-making not necessarily at the farm level but in the overall environment in which farmers (and processors) must operate; and
- Capacity building through undergraduate, postgraduate and short-term training.

Some examples of projects benefiting both Australia and collaborators are:

- Australia's multi-billion wheat industries are largely based on germplasm and technology developed in collaboration with the International Centre for Wheat and Maize Improvement (CIMMYT), Mexico.
- Collaboration with International Centre for Agricultural Research in the Dry Areas (ICARDA), Syria, has contributed to the development of Pulse industries in Australia (chickpea. lentil, faba bean, etc). **The net benefit for Australia from ICARDA germplasm is over $ 25 million per annum.**
- Similarly collaboration with International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) in India has benefited Australia through desi chickpea and sorghum germplasm **(the net befit is over $20 million per annum**). There are also numerous joint scientific papers and postgraduate students trained through collaboration with CIMMYT, ICARDA, ICRISAT and other CGIAR centres.
- Collaboration with China has seen germplasm exchange. Australia's canola industry has benefitted enormously from Chinese germplasm and also the hybrid technology,
- Australia through joint initiatives has contributed enormously through education and training initiatives (capacity building) in developing the next generation of scientists, agriculturalists and farmers – the people on whom the world will depend to solve the greatest challenge of human history – food security in the 21st century.
- Rehabilitation of rice production in Cambodia through AusAID support during 1980-1990s.

- The 'Seeds of Life' project in East Timor through UWA funded by ACIAR and AusAID commenced in 2005 with the goal of improving food security for East Timor by improved crop varieties and technologies which result in increased food production – critical for the country's independence and economic development. The project recently released new varieties of cassava, a staple food in East Timor, which yield up to 65 per cent more than previously farmed varieties. More than 60 varieties were trialled throughout the country from 2001 to 2008. From these, two varieties, Ai-luka 2 and Ai-luka 4, have been released to East Timorese farmers. They have been well received by local farmers, not just for their high yields, but for their good flavour as well.
- Australia's involvement with Iraq through a large project, 'Development of conservation cropping in the dry lands of northern Iraq', in partnership with ICARDA and supported by ACIAR and AusAID and training of young Iraqi agricultural scientists (at postgraduate level) at the Australian universities, is another example of Australia's strategic involvement in war-torn countries.
- Australia has also immensely benefitted by collaboration with USA, Canada, Europe and other advanced countries in agricultural science and education.

Professor Kadambot Siddique, FTSE,
Chair in Agriculture and Director, Institute of Agriculture
The University of Western Australia

Case 4.

Often the objectives of an international collaboration scheme (e.g. ARC Linkage International) are

- to build collaborations among researchers or research teams in Australia and overseas
- to generate opportunities for researchers to participating in leading-edging international research networks and strengthen their international research experience;
- to build Australia research capability by enhancing existing and developing new collaborations among researchers;
- to develop innovative modes of international collaborations; and to foster participation in global innovation networks.

In modern society, many problems are extremely challenging, and the solution to any of them needs to have a collective effort worldwide. Examples include energy and climate change at the global scale. This has also been the case for many large scale scientific and engineering problems which need the inputs from researchers of different expertise, skills and facilities. A few examples to show the (economic/financial) benefits to a university from the international collaboration are:

Example 1: Through the ARC Linkage International Scheme, UNSW (Prof. Aibing Yu) and University of Cambridge (Prof. John Bridgwater) have been working to examine the fundamentals governing powder mixing in bladed mixers on a particle scale. The study involves the use of the expensive experimental technique (called as the Positron Emission Particle Tracking) in the UK and the advanced discrete particle simulation in Australia. The two techniques are the complementary state-of-the-art techniques capable of generating particle scale information that is critical to better understanding of powder mixing fundamentals. With minor investment from the ARC Scheme (~$10k pa since 2002), the collaboration has led to the completion of 3 PhD theses and the publication of about 15 papers (each thesis and paper respectively represent >$80k and >$2.5k income to a university according to the current university funding system in Australia).

Example 2: Starting with a small fund (<$50k) for a workshop from DIISR (Australia-India Strategic Research Fund), Australian researchers (S Bandyopadhyay, M Green and A Yu from UNSW, G Lu from UQ, J White from ANU, and J Matisons from UFlinders) have recently developed a research program on "Nanocomposite materials for clean energy generation, storage, savings and safety" with their counterparts in India. The program is jointly sponsored by Australian and Indian Governments (each contributing $750k in total for three years). Expectedly, its conduct is very much beneficial to the participating universities, as it can lead to the graduation of 6 PhD students and a number of scientific publications, which in turn generates income for the universities (refer to the $ value above; note that each external $ may also attract 0.20-0.35$ to universities from the Government).

Example 3: Australia has successfully run a series of biennial joint symposia with Japan and China in ironmaking and steelmaking in the past ten years. Such joint meetings can provide to researchers and technologists direct access to the leading-edging science and technology, allow companies to showcase their own research and technological development, and offer a platform to exchange information and technology providing awareness of industrial needs. Moreover, they may help, though indirectly and difficult to value, the cooperation beyond research between Australia (as a major resource supplier) and China and Japan (as major resource consumers). The International Conference/Workshop Scheme, operated by ATSE, has played a useful role in maintaining this important symposium series.

Professor Abing Yu FTSE, ARC Federation Fellow,
Scientia Professor, School of Materials Science and Engineering
University of New South Wales

Case 5

The stand-out results from international collaborations which had ATSE involvement are:

- Australia-China Water Centre (arising from China Australia symposium);
- Australia-China Phenomics Centre (Australia China Young Scientists Exchange);
- Australian eResearch Program (arising out of mission to UK); and
- Square Kilometre Array.

Modern research is based on creation of teams of critical mass, large collaborative frameworks, and access to large scientific instruments. Increasingly the leading edge of this research is carried out by multi-disciplinary and multi-national teams, and Australian presence and interaction with international efforts is increasingly the key to our country's success at scientific and innovative endeavours.

Traditional areas of research involving extensive international interaction, such as astronomy, continue to grow as areas of international collaboration. These areas of collaboration are now extending to medical and social sciences, with life sciences, drug development and response to global pandemics based on establishing and established international effort. Examples of Australian collaboration include our partnership in the European Molecular Biology Laboratories (EMBL), collaboration in immunology, participation in genomics and phenomics research, and bioinfromatics.

Global issues such as environmental impacts and climate change modelling need Australia to play its part. The network of meteorology research, climate observation and modelling provided by Australia in the terrestrial research network, and by the integrated marine observing system provide strong links to international effort in these areas of research.

Dr Mike Sargent AM FTSE
Director, M A Sargent and Associates Pty Ltd, ACT

Case 6

As a physicist, international collaboration provides access to knowledge and facilities that exceed those available within Australia. At present I am involved in several collaborations involving the EU Framework programs. In some cases this has allowed us to access facilities not available in Australia, in other instances our science contributes to larger programs involving multiple partners in the EU. In most of these cases we are only able to participate provided funding is available from an Australian source: most often the Australian Research Council. A difficulty we presently face for example is our commitments to these EU programs do not have guaranteed on-going funding from the Australian end. I strongly support the notion that a funding framework should be in place to help support the Australian involvement possibly involve bilateral agreements. A model could be for Australian funding to match dollar-for-dollar funding allocated to Australian participants from the EU. This represents, in our case, an amount of around $25,000 per annum per project.

In terms of triple-bottom-line, the outcomes of such collaboration contribute to knowledge in my case connected with future information technologies. This technology may contribute to the future of the internet with obvious financial and social advantages connected to initiatives in broadband. In the past I have been involved helping establish start-up ventures most notably during my association with the Australian Photonics CRC. My research helped establish a local company RPO Inc, which has

developed a novel touch screen display technology for consumer markets. In the early phase of the research that led to RPO we were involved in an international collaboration with Korea via a bilateral agreement. This was invaluable in establishing the program that ultimately created RPO. Ten years on, RPO is in the process of establishing manufacturing for its technology in collaboration with a major Asian manufacturer. The successful launch of the product would clearly help maintain intellectual resources and contribute to financial resources in Australia.

Professor Barry Luther-Davies FTSE
Head Laser Physics Centre
Australian National University

Case 7.

Government research funds have enabled us to construct a unique spectrometer which is currently a "highlighted" instrument on the Berlin synchrotron radiation source. The instrument's special abilities have attracted some six German research groups to request regular access to this spectrometer. We consider this to be a significant example which showcases Australian science to advantage in a sophisticated international setting. A further spectrometer is currently being constructed at La Trobe (ARC funding) for use at the Australian synchrotron. Commercial value (were it to be so available, would be approximately $2 million).

Professor Robert Leckey
LaTrobe University, Victoria

APPENDIX II

Views & Experiences from the Coal Face:

Some experiences of international research collaboration.

Professor Andrew Holmes FRS FAA FTSE
Laureate Professor and CSIRO Fellow,
Bio21 Institute, University of Melbourne

I can point to a number of international collaborations which have allowed us to define Australia's international position in organic photovoltaics. However, let me start by outlining "the obvious". Why is it essential for Australia to participate in international collaborative projects?

1. Australian researchers need to have hands-on experience in carrying out research alongside those from other countries, particularly the best in the world.
2. Owing to the distance from many other centres of excellence it can be very tempting for Australians to claim to be the best in the world without putting it to the test. International collaborations force us to benchmark ourselves against the best, and our claims can then be independently substantiated.
3. Just as the best science is now being carried out at the interface of disciplines, so is some of the best science being carried out through international collaborations.
4. The globalisation of science means that researchers must be networked with the rest of the world. An example of this comes from my own experience as a partner in many EU framework projects when living in the UK. Our networks ended up training a very large fraction of the individuals who were employed in the organic electronic materials industry in Europe, and they all knew each other through the EU framework collaborations.

When I came to Australia in 2004 there were a few isolated groups working on organic photovoltaices and dye-sensitised solar cells. Through a $1.2 million DIISR ISL (ICOS) three-year project we were able to unify the Australian effort (seven institutions - Melbourne, CSIRO, Monash, Wollongong, Sydney, Newcastle, Queensland) and join with the world leaders in organic photovoltaics in the UK (Imperial College and Merck Chemicals), USA (Cornell and Georgia Institute of Technology), Singapore (A*-STAR Institute of Materials Research and Engineering) and New Zealand (University of Otago). We also had in-kind contributions from BP Solar and BlueScope Steel.

The outcomes to date are:

1. Unification of Australian research activity into a strong network;
2. Establishment of an Australian OPV DSC (organic [photovoltaic dye sensitive cells) community of 130 researchers;
3. Put the Australian effort fairly and squarely on the international map;
4. joint publications;
5. Sent Australian researchers to laboratories abroad and created postdoctoral appointments abroad
6. Enabled further funding from the Vic State Government ($6 million for a $12 million project - VICOSC)
7. Enabled further funding from Queensland State Government (NIRAP $2 million) to University of Queensland.

A further German Academic Exchange Service (DAAD)-Go8 funded collaboration between Uni-Ulm and University of Melbourne has resulted in the publication of six joint papers and a subsequent application to DIISR for an ISL project under the recently agreed Australia-Germany collaboration. It is my understanding that DAAD-Go8 established the program because they were unable to wait any longer for DIISR to do something about Australia Germany collaborations. For the whole time that I have been in Australia since 2004 I have been on long-term leave of absence from Imperial College, UK. I am now an Emeritus Professor at Imperial. This link has enabled me to send a number of Melbourne and CSIRO researchers to Imperial for research collaborations. We are now exploring the possibility of a CSIRO-Imperial College collaboration. It is understood that Imperial College would be interested in supporting joint PhD degree research collaborations.

Dr Peter Crawford FTSE
Adjunct Professor, Newcastle University
Two key areas where international collaboration in research and application contribute health and environmental benefits at reduced cost to Australia:
1. Major international programs on chemicals hazardous to health and the environment- which at the same time can be important in economic development and in the protection of health, agriculture and the environment, when properly targeted and used: There is a need to link efforts to reduce risk in use while recognising the many real and potential benefits of thousands of new and existing chemicals. Australia has been an active contributor to major OECD, WHO and UN Agriculture programs dealing with chemicals over many years. I led the OECD program in 1979-1982. It involved many hundreds of scientists, industry experts and officials. When these experts work together they acquire new skills and knowledge, demonstrate and build on our Australian expertise and skills and help to ensure that regulation, national and international, is efficient and well targeted. There are many associated commercial interests.

2. Water. For example, there are national and international benefits in sharing knowledge and technological advances in waste water treatment and particularly in recycling for potable reuse. Given water scarcity in this country and the demands that are increasing in our cities we will eventually be obliged to face up to potable reuse. While we are little involved directly at present we have much to learn and in many areas we have excellent technology and expertise to contribute eg membrane technology. This creates a useful commercial and technological interchange in an arena of critical national importance.

Professor Rao Kotagiri FAA FTSE
Department of Computer Science and Software Engineering
University of Melbourne
Some of the key reasons for the desperate need for international collaboration in Australian Research are:

1. Science is international and applicable to all societies and all nations, and many advances in science and technology and engineering are occurring at a rapid pace- collaboration facilitates rapid and timely access to new developments, globally.
2. Many counties and Societies face very similar problems- e.g. Health, Pollution, Food, Education, the challenge of providing services efficiently, effectively and equitably, aging populations, resource shortages and lack of infrastructure. Collaboration means we can get the best out of every dollar spent on science, technology and engineering research on these issues.
3. Minimise any duplication in research efforts and maximise the ability to tackle large-scale science and engineering problems by pooling international resources.
4. Collaboration can accelerate the development of intellectual capital and potentially higher rewards in terms international prestige and establishment of joint new industries.
5. Collaboration provides Australian researchers access to research infrastructure and major instruments, laboratories and information sources otherwise not available in Australia.
6. Collaboration will reverses the "brain drain" as bright researchers will not be disadvantaged by being in Australia as they would be able to collaborate with the best anywhere in the world.
7. Collaboration is essential for establishing quality educational institutions. Collaboration can help in curriculum design and educational practice in terms teaching and learning.

To be able to benefit from the global science and technology research "pool", collaborations have to be mutually beneficial to participants. To be accepted as a collaborator on international research projects is a measure of the quality of the participant's research. To be prevented from doing collaborative international research due to lack of national funding support will stall the innovation in Australian scientific knowledge and application. ARC for the last five years has helped establish one off international links through ARC Research Networks ($300,000 per year). These networks were established in specified areas of research and have helped immensely for those who were members of these Research Networks. There were 24 such networks established which have had direct and positive

impact on establishing collaborative research activities in Australia. Some research networks had attracted annual total funding of the order of $700,000 to $1million through links with industry and research institutions. Unfortunately this program no longer operates with the resultant decline in the continuation of existing collaborations and establishing new collaborations. I would expect funds of $200 million may be needed to establish quality, high impact collaboration in all fields of Science, Engineering, Medicine, Commerce and Social Science.

Professor Kaye Basford FTSE
University of Queensland

Our involvement in current EU FP7 proposals is in jeopardy because we have no means of applying for funding from Australia. International collaboration with scientists in overseas universities and international agricultural research centres are crucial as they enable us to share the latest advances in plant improvement. Non-involvement puts is behind the rest of the world.

EU and ISL

A colleague is a partner in an approved EU (European Union) FP7 project. It is called DROPS – Drought tolerant yielding plants – and is being funded at 6M Euros over 5 years. Because the ISL (International Science Linkage) funding is currently not available, he has been given $200K from DIISR for 1 year to enable him to be involved. This work will help Australia (the driest continent) and is incredibly leveraged. However, if we don't have some way to get funding in Australia we are probably going to be eliminated from such projects.

I am partner in another EU FP7 project which is being submitted shortly to follow on from a funded FP6 project. The new one is called Clinical applications of ImmunoGrid (the earlier one was ImmunoGrid, an integrative environment for large-scale simulation of the immune system for vaccine discovery, design and optimization) and my component is worth about $400K over 3 years. However, I have grave doubts about involvement if we have no ability to apply for Australian funds. Again there would be benefits for Australia (but I haven't quantified them). The overall project is worth about 4M Euros over 3 years.

Emeritus Professor Bruce Holloway FTSE
Monash University

I stress the importance of international collaboration in Stem Cell Research. Australia has a good position in this area which could be quickly lost if we minimise our international collaborations, the topic is an international one, still in its early days and exclusion of Australian researchers could have long term negative results for health costs and social benefits in Australia.

- A general comment that should be made is that any reduction of existing financial arrangements would have a disproportionate effect on the programs and projects already active. Thus money already spent would be to a large extent wasted.

- Projects involving biotechnology, particularly those for medical research, always have a long lead time to commercialisation and need patient money so that the effects of funding cuts would be particularly disruptive.

- This is particularly true for Stem Cell Research. The Victorian Government in May 2009 funded a cooperative venture between research institutes in Victoria and the California Institute for Regenerative Medicine. Any reduction of Federal funding for international collaborative research would be seen by the states as an argument for decreasing or cancelling their involvement in such arrangements.

Stem Cell Research is likely to be effective in curing or alleviating diseases that cannot be current medical treatment. These include Alzheimer's Disease, Parkinson's Disease and diabetes. Diseases such as these have a high social and economic impact and loss of research collaboration opportunities through lack of federal funding will mean that Australia may not benefit from the economic and or therapeutic gains this research field promises.

Dr Tom McMeekin FTSE
Professor of Microbiology,
Co-Director, Australian Food Safety Centre of Excellence

A list of grants from the Australian Government sources for international research follows. All except one were small amounts, and in most cases the outputs were publications and exchange of postgraduate students. Also, in most cases the collaboration continues eg. With Professor Mojens Jakobsen University of Copenhagen, and Dr Jean Guezennac, France (microbial exopolysaccharides), Professor Jakobsen is the leader of Pathogen Combat an EuFP6 project which had up to 44 participating laboratories and University of Tasmania. (see www.pathogencombat.com for an overview).
The exposure gained in Europe from these activities lead directly to further collaborations with Professor Stanley Brul, University of Amsterdam and Unilever (Europe) on molecular approaches in food microbiology and development of Systems Biology approaches; with Dr Pav Dalgoord, Danish Technical University - predictive models and devices for food safety and stability and Professor Erwin Golmski, University of Bonn, Germany – microbial stress physiology. A patent application has been filed on a novel antimicrobial which also has nutritional properties and is already approved for human consumption.

Beyond the European connections the ATSE sponsored Australia/China workshop in Hobart led to my appointment as an Honorary Visiting Professor and at Nanjing Agricultural University.

In 2010, Professor Golmski visited the University of Tasmania and a postgraduate student from Bonn is working at University of Tasmania from January to May this year. Dr Shigenobu Kosebi from Tsukuba, Japan arrived this week for one year sponsored jointly by the Japanese and Australian Academies of Sciences. Finally it may be worth noting that in food safety the norm is to publish rather than protect research findings. The rationale is that greater benefit will accrue from free access to research outputs by regulators and industry. A case in point is the application of University of Tasmania generated Predictive Models for E. Coli . These are now incorporated into regulations for the chilling of meat carcasses in Australia. Meat & Livestock Australia, which funded most of the research, commissioned an economic analysis by the Centre for International Economics (ACT). A benefit cost ratio of 11:7 was calculated.
An international outcome of Risk Assessment carried out at University Tasmania by a Thai student, supervised by Dr Tom Ross, led to a change in regulations on levels of histamine in fish and fish products by the CODEX Alimentarius Commmission – the world's peak body on food safety matters.

Grants from the Australian Government sources for international research:

DITR – Grant -Technology Diffusion Project Predictor Micro. Technology – International Research Links $15,715
DITR – Grant – Diffusion Technology Project: Symposium on the interface between Analytical Chemistry and Microbiology $4,260
DITR- Grant- Diffusion Technology Project: Environmental stresses on the food borne pathogen Listeria monocytogenes $9,400 This led directly to funding from the Royal Veterinary and Agricultural University for collaboration between University of Tasmania and RVAU into the response to bacterial stress. $11,400
DEST – Grant – Aust Industry Innovation Access Program. Collaboration in development of BBACANOVA an Eu FP project $6,600
DEST – IACCp. Bacanova Eu FP project. $3,300
DEST –ISL Participation of Australian Food Safety Centre for Excellence in EuFP6 project $100,000
DEST- ISL – project as above $ 5,579
DEST – ISL- project as above $20,000

Nunzio Motta, Queensland University of Technology

The quantification of the cost benefit is quite difficult, however my personal feeling is that Australia absolutely needs contacts with overseas scientific organizations, due to its size. These contacts are extremely important for the formation of the young generation of scientists, producing a boost in their productivity. This also increases the number of overseas students and scientists which desire to come to Australia. One concrete example is my student: he produced 2 papers on APL and one in Advanced Materials after a 2 months visit in Roma Tor Vergata, using their Ultra High Vacuum STM, not accessible in Australia. Now he is in Canada for 2 months to use a similar instrument at NSERC with ARNAM funds.

Associate Professor Amanda Lynch FTSE,
School of Geography and Environmental Studies
Monash University

There are particularly important benefits of international collaborations for researchers in place-based fields, particularly in the earth, oceanic and atmospheric sciences. Australian researchers conducting research that has a broader remit than a focus specifically relevant to Australia, and hence can have much greater impact. However, this can be problematic: for example, Neville Nicholls wrote in an opinion piece in the Australian on June 25th, 2008:

"*In the 1990s, colleagues and I published two short papers showing that tropical cyclone activity had declined. One paper demonstrated this decline for the North Atlantic Basin, the other for the Australian region. The North Atlantic paper is my fourth most cited paper. The Australian paper is ranked 44th, with less than a quarter of the citations of the North Atlantic paper. The North Atlantic paper is cited more frequently because there are more climate researchers in North America and Europe with a specific interest in North Atlantic cyclones. But which paper is more relevant to Australia?*"

Thus, international collaboration is something of a double-edged sword: good for the researcher working in what is an essentially international profession, but certainly problematic for a government that is trying to manage priorities. That said, on the purely positive side, international collaboration is extraordinarily important for field work and the use of large, expensive instrumentation. My collaboration with US and European counterparts means that I can access Antarctic ships and ice breaker vessels with a much broader range of operations than the Australian resources provide. I have been able to access data collected by Finnish cruises and participate in programs flying autonomous aircraft from McMurdo. I can obtain berths for my post-graduate student and post-doctoral fellows, providing invaluable training. Similarly, my collaborations with the US National Center for Atmospheric Research have allowed me to access supercomputing and data resources at the Center, and to send my students to specialized training there.

Dr Matthew Todd, Senior Lecturer, School of Chemistry, University Of Sydney

On my recent visits to Shanghai and Beijing (especially Peking University) [as part of the ATSE international exchange program for emerging leaders] it became clear that the best undergraduates and postgraduates go to the US, for PhDs and post doctoral fellows, respectively. This is partly because of the quality of the science that goes on there, but partly because it's the "done thing". Publicising Australian science will help to divert some of this talent to Australia, without a doubt. A member of faculty in Renmin University, Beijing, is now a PI on a grant I submitted to the ARC this year.
I have no doubt this will lead to some of his students wanting to work in Australia in the future.

The second benefit: there really is no decent international grant funding mechanism for adventurous research across continents, aside from the HFSP program. This morning I learned that the grant I submitted to this program, which was shortlisted for full submission last year, was narrowly unsuccessful. My co-investigators are from top universities in the US and UK. There is nowhere else that will consider grants like this, yet the research would have brought valuable expertise into Australia through postdoc exchange. The subject area of the research was a new field of biotechnology - quantum dots - that is undoubtedly going to be a major wealth generator. Australia must be part of moves to allow us to take part, at a high level, in large multilateral programs like this, or else we risk losing out to consortia of researchers within the US and EU that find it quite easy to generate money for collaborative efforts more locally.