# FEAST

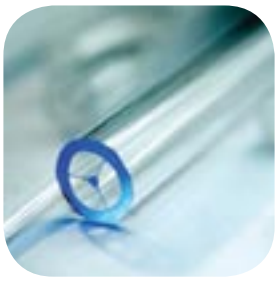
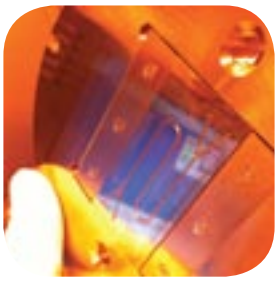
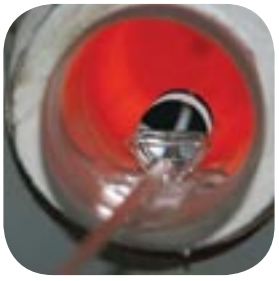
Forum for European-Australian Science and Technology cooperation

ANFF

Australian National
Fabrication Facility Ltd

# *Providing nano and microfabrication facilities for Australia's researchers*




An Australian Government Initiative
National Collaborative Research Infrastructure Strategy


## Australian National Fabrication Facility

151 Wellington Road, Clayton VIC 3168
Phone: 0438 454 077
Email: info@anff.org.au


*www.anff.org.au*


Established in 2007, under the National Collaborative Research Infrastructure Strategy, ANFF links 7 university-based nodes to provide researchers with access to state-of-the-art fabrication facilities.

This capability enables users to process hard materials (metals, semiconductors, composites and ceramics) and soft materials (polymers and polymer-biological moieties) and transform them into structures that have application in sensors, medical devices, nanophotonics and nanoelectronics.

ANFF nodes have 'cutting-edge' equipment and the ability to conduct a number of processing steps to produce an end product in a clean environment. Each node offers expertise in a specific range of areas to meet researchers' diverse fabrication needs.

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## FOREWORDS



## INTRODUCING FEAST



## AUSTRALIA

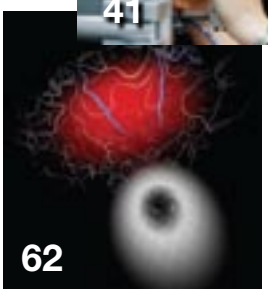


*Special Research Focus Areas*



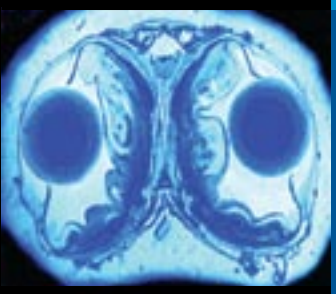


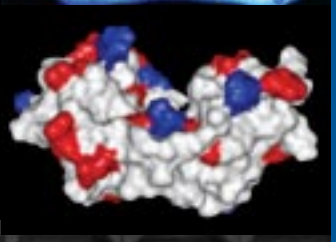


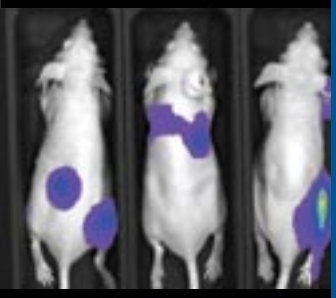


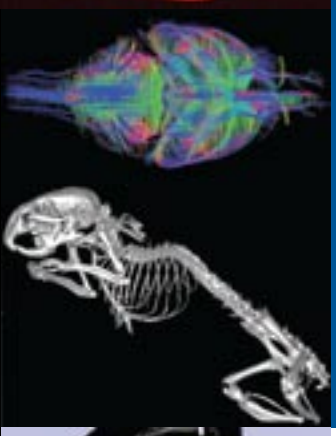
# National Imaging Facility

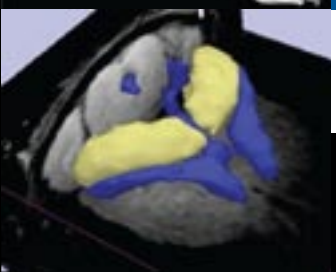
www.anif.org.au











## Excellence in Imaging Research

**Australian National Imaging Facility** (NIF) provides state-of-the-art imaging of animals, plants and materials for the Australian research community. NIF's grid of imaging facilities across Australia provides a range of leading-edge imaging instrumentation, advice and assistance in the optimal use of imaging to the research community.

### Capabilities

Specifically, the NIF provides:

- Access to molecular imaging instrumentation, including a range of MRI and PET scanners;
- Access to other live animal imaging equipment including bioluminescence, microCT, ultrasound and intravital microscopy;
- Development and validation of novel biomarkers/radioligands for in-vivo imaging using PET and MRI;
- Development and application of stable isotope-labelled analogues to new radioligands;
- Small and large animal imaging
- Magnetic resonance spectroscopy, coil design and pulse sequence development;
- Application of these new technologies in large-scale trials in animal models of disease;
- Bio-mathematical modelling of tracer kinetic data and integration of the high-dimensional data in a dedicated neuroinformatics system;
- The creation of databases of normative data, and a common platform of base data;
- Preclinical trial imaging
- Fully equipped and staffed large animal surgeries with anaesthetic and physiological monitoring;
- GLP accredited laboratories and
- Animal ethics committees.

### International Users and Collaborations welcomed with subsidised access available for Australian users

The University of Queensland; Small animal Imaging (MR-PET (2010/11), PET-CT, 16.4 T MR, 4.6 T MR), Whole body MR (1.5 T MR, 3 T MR, 4 T MR) The University of Sydney; Research Cyclotron (2010), MicroPET, MicroSPECT, Beta Microprobe, Medicinal Chemistry Lab, NIF Radiochem Hot Cell, Pharmacology Biodistribution lab, Biomodelling lab. The University of New South Wales; 3 T MR whole body scanner, IVIS lumina live imaging, Faxitron X-ray, Vevo 770 Ultrasound microimaging, Skyscan1072 Micro CT. University of Western Sydney; 11.7 T MR scanner, 7 T MR scanner. Large Animal Research & Imaging Facility; 1.5 T MRI, DEXA, Angiography suite/ Image intensifiers, Large Animal CT, Digital X-ray. The Florey Neuroscience Institutes; 4.7 T MR scanner.The University of Western Australia; Small animal imaging (micro-CT and multispectral imaging).

The University of Queensland · UNSW · University of Western Sydney · Florey Neuroscience Institutes · Monash University · The University of Sydney · Large Animal Research & Imaging Facility · IMVS · The University of Adelaide · UniSA · The University of Western Australia

NIF is funded by the Host Institutions and Government Funding Bodies

An Australian Government Initiative
National Collaborative Research Infrastructure Strategy

Queensland Government · New South Wales · Government of South Australia

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Editor: Dominic Cadden
Art Director/Layouts: Anthea Vandertouw
Cover Design: Roxby Media Ltd UK
Editorial assistant: Siobhan Bear
Picture Editor: Juliana Penteado
Media & Events Manager: Sandra Johansson
Event Photographer: Advent Photography
Sales Manager: Peter Ratcliff
Sales Director: Stephen Crowe
CEO: David Collett

ROXBY MEDIA LTD AUSTRALIA

Roxby Media Australia
Suite 804, 37 Bligh Street
Sydney NSW 2000 Australia
Tel +61 2 8246 7400
Fax +61 2 8246 7444
www.roxbymedia.com.au

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## EUROPEAN UNION




## NEW ZEALAND



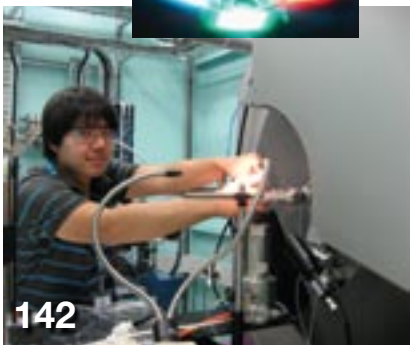

## SCIENCE DIPLOMACY

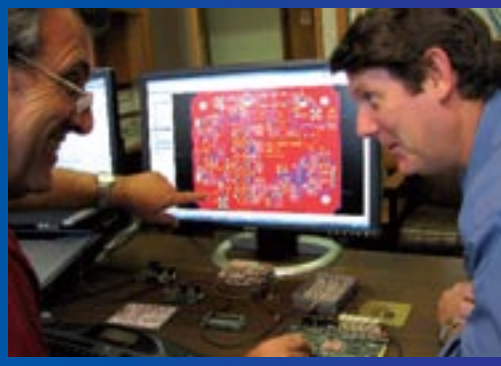




## AUSTRALIA & FP7







# *A brighter future*

**James Cook University** is located in northern Queensland within the spectacular World Heritage listed areas of the Great Barrier Reef and Wet Tropics. JCU is widely recognised as the world's leading university in tropical marine biology and ecology.

The University hosts the headquarters of the **ARC Centre of Excellence for Coral Reef Studies**. The Centre is a partnership between JCU and 29 institutions worldwide.

The ARC's Centre is a world leader in coral reef science citations and graduate training, providing an ideal hub for research collaborators and PhD students.

In 2012, The ARC Centre and James Cook University will host the 12th International Coral Reef Symposium in Cairns, Australia.

**www.coralcoe.org.au**



12th International
Coral Reef Symposium
9-13 July 2012 • Cairns • Queensland • Australia

ARC Centre of Excellence
Coral Reef Studies

JAMES COOK UNIVERSITY
AUSTRALIA

Celebrating 40 YEARS 1970~2010

# A global university like no other

**Global challenges require a new level of international collaboration and understanding. That's why Monash University has invested in campuses on three continents, a centre in Europe and builds strong partnerships with universities, governments, industries and NGOs around the world.**

In Europe you'll find Monash working with partners in solving the challenges of urban water supply and sanitation for cities, striving to find new treatments for cancer and malaria, developing chemical products and processes that use less energy, generate less waste, and replace hazardous substances with benign alternatives.

Monash researchers also engage in projects focused on reducing the incidence and severity of road accidents in Europe and Australia, and work on new perspectives on global population movement and social inclusion.

Further afield, our researchers are working on challenges that include point-of-care diagnostic devices for remote and rural communities, modelling the impact of economic policies for government and developing new insights into education across borders.

This is only part of the story.

To learn more about Monash University and its global achievements and work visit **www.monash.edu**

Go Boldly.

MONASH University

# Collaboration the engine of innovation

**Senator Kim Carr**
Australian Federal Minister for Innovation, Industry, Science and Research

Australia and Europe share a vast amount of history and culture. This common heritage gives us a solid foundation for research collaboration.

Collaboration stretches our dollars – or euros – further. It spreads risk and allows us to increase skills and knowledge in both Europe and Australia. Collaboration is the engine of innovation.

The European Union is Australia's largest scientific partner. Since the Australia-EU Science and Technology Agreement was signed in 1994, Australia and Europe have agreed that we need to establish priorities if we are to collaborate effectively. The task of setting those priorities falls to the Joint Science and Technology Cooperation Committee. Australia will host the committee's next meeting in June 2010.

Europe and Australia each bring special strengths to the partnership. The Australian Innovation System Report 2010 found that Australia ranks among the top one third in the OECD for research capacity and skills; gross expenditure on tertiary education; proportion of population with a tertiary qualification; new PhDs; and professionals and technicians in the workforce.

We have also each developed policies and programs to encourage collaborative activity. The EU Framework Program for Research and Technological Development is perhaps the most striking of these. Australian researchers have participated in over 500 framework program projects since the 1990s, including many in the seventh program – FP7 – which runs from 2007 to 2013.

Meanwhile, the Australian Government has invested $4m in the Australia-Europe Research Collaboration Fund, and opened Australian Research Council awards and fellowships and the CSIRO Flagship Collaboration Fund to international researchers.

Our new R&D tax credit will be accessible to foreign companies that do R&D through a permanent establishment in Australia, and to companies that hold their intellectual property offshore.

We have also expanded Australia's role in iconic collaborations such as the European Molecular Biology Laboratory and the Square Kilometer Array radio-telescope.

The highly successful Cooperative Research Centres Program, which brings private industry together with university and other researchers, is actively targeting international partnerships.

At the same time, we are investing $20m a year in International Postgraduate Research Scholarships, giving overseas students the opportunity to gain experience with leading Australian researchers.

The Australian Government is also proud to join with the European Union in supporting the Forum for European-Australian Science and Technology Cooperation (FEAST), which plays a vital part in promoting and facilitating collaboration between the two communities.

Initiatives such as these promise enormous benefits to Australia, Europe and the world. They promise us closer and more fruitful collaboration. They promise us solutions to some of the great challenges of our time. They ultimately promise us a better future. That is what the rich and enduring science partnership between Europe and Australia is all about.

**Australia ranks among the top 1/3 in the OECD for:**

- **research capacity and skills**
- **gross expenditure on tertiary education**
- **proportion of population with a tertiary qualification**
- **new PhDs**
- **Professionals and technicians in the workforce**

> The highly successful Cooperative Research Centres Program, which brings private industry together with university and other researchers, is actively targeting international partnerships

# CONNECTING THE BEST
## EUROPEAN AND AUSTRALIAN MINDS

RMIT University established its European Union (EU) Centre in January 2010. The EU centre provides a focal point for teaching, collaborative research and sharing of information between the EU and Australia. Already it has proven a success, acting as a gateway of information and knowledge from academia to industry and the community at large.

The EU Centre at RMIT is one of only four EU Centres in the Southern Hemisphere, and undertakes a range of activities to provide information to the European Union scientific community about research taking place in Australia.

For example, RMIT University is currently investigating how 'cone snail' venom can alleviate serious chronic pain. Currently one in five Australians suffer from chronic pain, and unfortunately there are few options to help. Through advanced research and investigations by the RMIT Health Innovations Research Institute, peptides derived from cone snail venom have been identified as a new relief and way forward without side effects.

The research has been backed by an Australian Research Council grant of $1.4 million, and RMIT is working with one of the world's leading cone snail experts, Professor Frank Mari at Florida Atlantic University. The collaboration with Mari means RMIT can now broaden its investigations beyond Australian species. The team also works with researchers in the University of Calgary and a group based in Belgium, sharing their raw cone snail venom material, which is then synthesised for analysis.

Through collaboration, this type of research is one of many examples of information that could be shared through the EU Centre at RMIT to provide knowledge across the globe.

www.rmit.edu.au/research

RMIT UNIVERSITY

# FEAST, the EU and the Knowledge Triangle

**His Excellency Ambassador David Daly,** Head of the European Union's Delegation to Australia

Research, education and innovation are the three points of what is known in Europe as the "Knowledge Triangle". At the apex of this triangle, is a smart, sustainable, growing economy.

What this means is a Europe where excellent research takes place, which improves our knowledge capital and leads to innovation in successful and dynamic businesses, as well as being a place where the most talented people want to live and work.

The Europe 2020 Strategy names three key areas to keep Europe growing and research and innovation are the first of these. Innovation is the central plank of the European Union's future economic policy. The idea is to take the European Union (EU) and turn it into an Innovation Union.

European Science policy is guided by two important concepts – the European Research Area (ERA) and the fifth freedom.

The first concept, the ERA, encompasses all European research activity – not just the Framework Programs (FP), which in themselves have grown exponentially in size since their launch in 1984 (FP1 = €3.27 billion, FP7 = €50.5 billion). The ERA includes the FP, intergovernmental programs and the national programs of our Member States. In ancient times, the work of individual philosophers could bolster our collective knowledge. In today's interconnected world, where global challenges require global solutions, collaborative research is a must. We have already made good our objective to create a European unified research area where researchers and knowledge can move freely across national borders. In recognition of the importance of international scientific cooperation, the EU has Science & Technology Agreements with 19 countries around the world (including Australia).

The fifth freedom relates to knowledge. The European Union was built on the foundation of four freedoms – the freedom of movement of people, goods, capital and service. This was the basis of the Single European Market. The aim for 2020 is to achieve a genuine European Knowledge Economy, in which all actors benefit from the free circulation of people, knowledge and technology (the fifth freedom).

International R&D today is more important and more necessary than ever. It underpins the basic rationale behind the concept of the European Union – i.e. working together for our collective interest. The objectives of international cooperation were clearly set out during the drafting of the latest Framework Programme – FP7. They are:

(a) to support European Competitiveness,
(b) to contribute to sustainable development,
(c) to enhance European scientific excellence (and therefore attractiveness to the rest of the world), ➤

> FEAST was, and continues to be, a flagship initiative. Its success has been copied around the world and its name is synonymous with excellence in terms of collaborative outcomes

**1:23**

**– the approximate leverage factor of funds brought by Australian participants to projects with EU partners**

(d) to address global challenges,
(e) to contribute to EU external relations policies. Internationalisation is therefore seen as an opportunity not a problem.

R&D cooperation does not operate in a vacuum. It plays a key role in all the EU's policies, including the establishment of new bilateral and bi-regional policy dialogues and frameworks. The EU-Australia Partnership Framework is a good example where cooperation on science, research, technology and innovation plays a major part in the overall EU-Australia relationship.

Australia and the EU are committed to building on our current S&T Agreement to develop a broader and deeper partnership in this field. The European Union is Australia's largest scientific partner and our collaboration is already bearing fruit. Since the S&T agreement was signed in 1994, there have been over 200 projects with Australian partners. While Australian participants usually have to bring their own funding to the project (although there are exceptions to this), the leverage factor is roughly 1:23. In other words, for every €1 the Australian participants have spent, they have leveraged approximately €23.

One of the key joint projects is the Forum for European Australian Science & Technology cooperation. This project has been jointly funded by the European Commission and the Australian Government since 2001. Its mandate is to promote, facilitate and evaluate collaboration between the EU and Australia with the specific objectives being to increase the links between European and Australian researchers; to identify and demonstrate the cooperation; to act as a two way information centre on both Australian and European Programmes and to exchange best practices. FEAST was, and continues to be, a flagship initiative. Its success has been copied around the world and its name is synonymous with excellence in terms of collaborative outcomes.

I am proud to be the Ambassador and Head of Delegation of the European Union to Australia. I am proud of the depth and breadth of our relationship and I am especially proud to support our continued collaboration in science, research and innovation. Let me make a final point of logic. The European Union is the world's greatest peacekeeping experiment – "Peace cannot be kept by force. It can only be achieved by understanding" (Einstein). Understanding can only be achieved through knowledge.

> "the idea is to take the European Union and turn it into an Innovation Union"

I commend this publication to you and I am confident that it will add to the already considerable amount of R&D collaboration between the EU and Australia and beyond. ■

# HOW DOES BEING SMALLER HELP US GET BIGGER RESULTS?

Some call us small. We call it fat-free. It's research focus, coupled with research agility. As such, our ability to turn ideas into commercial partnership opportunities is exceptional. Just ask Boeing, Ford and Suntech Systems.

And despite our size, citations of Swinburne's research have grown 250 per cent since 1999, a rate of growth that outstrips all the Go8 universities.*

Combine this with a major investment of $250 million over four years, and our quest for research excellence is unparalleled.

**RESEARCH AT SWINBURNE**

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SWIN BUR NE

SWINBURNE UNIVERSITY OF TECHNOLOGY

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# THE FEAST EXPERIMENT
## recent experience and future prospects

The *Forum for European-Australian Science and Technology cooperation* (FEAST) has existed for the best part of a decade. It has been a pathfinder initiative that has influenced the European Commission's thinking about how to configure and manage relationships with Third Countries.

The publication of this volume on FEAST, and on the wider issue of 'science diplomacy', provides a useful opportunity to step back and review what FEAST has achieved – and where it is going. Specifically:

- what the unit has achieved;
- what FEAST has not been able to achieve (and why);
- what we have learned;
- the broader context in which FEAST now operates;
- future directions – where are we going in this sort of facilitation role.

### What has FEAST achieved?

In broad terms:

- we have promoted self-reliant strategies and tactics in the research community via pragmatic thinking (explicitly balancing risks versus rewards);
- helped with some aspects of policy-making by providing useful analyses, e.g. our bibliometric work on the benefits of bilateral versus multilateral research cooperation;
- created an evidence-base on the current state of Australian participation in FP7 (notably via our comprehensive 'Stocktake' survey in 2009);
- built some effective relationships that allow us to facilitate a two-way flow of information and insights – especially as regards 'policy shaping' ideas; and
- developed and, are now moving on to pilot, online decision-support and progress tracking tools for researchers and research managers.

### What have we not been able to achieve? – and what does this tell us

We have struggled to reach enough of our 'client base' (as revealed by the 2009 Stocktake – see p.146). It is probably fair to say that the researchers who contact us for advice are those who least need it. Our major challenge is to engage with researchers who bypass both the Australian National Contact Points for FP7 (NCPs) and their own research offices – and who, as a result, can come unstuck. The fact that a prospective FP7 consortium member is not required to get formal institutional sign-off on an FP7 proposal is a major problem.

### What have we learned?

Firstly, it can be hard to convince Finance ministries of the 'return on investment' from supporting international research collaboration. Whilst the growing focus on 'innovation' may make this challenge easier it also creates a dilemma. Innovation is largely a competitive national issue. However, this is not the case for public science, which, aside from the national security dimension, is inherently concerned with collective international interests. So, the sort of argument that may have traction in Finance ministries at present (the innovation imperative) is also an argument that is less conducive to support for international research collaboration.

Secondly, we need to transition the NCP function to a distributed network with nodes firmly embedded in research offices. We are therefore working on forming a suitable partnership with another organization and/or professional association.

Thirdly, we need to force all Australian researchers to consult the NCPs and their research offices – thus avoiding the 'bypass' problems we are observing. We have proposed an *NCP File Number linked to an NCP Case Management System* designed to make a distributed NCP network effective.

Finally, we need to encourage and discourage where appropriate. FP7 is not for everyone. Australia has a very competitive success rate in FP7 in part because we are active discouragers of participation in uncompetitive FP7 proposals. Our explicitly risk-reward based ethos helps here.

### The broader context in which FEAST now operates

It is worth drawing attention to two emerging features of international research cooperation:

- a growing emphasis on openness and reciprocity considerations when examining how different nations' research funding systems are configured;
- an increased priority being placed upon major international cooperative research addressing global challenges.

In this context, FEAST's experience suggests that it might be useful to frame things around the notion of *interoperability* – the capacity to configure cooperative activity quickly and cost-effectively in such a way that it exploits

Dr Mark Matthews, FEAST

Mark Matthews was former Executive Director of FEAST. He now serves as Executive Director at the HC Coombs Policy Forum.

complementary capabilities. We like this concept because it takes us further than more rigid project-based approaches (characteristically slow to start and hard to re-direct in the light of experience and unanticipated developments). Interoperability – based approaches exploit synergies between existing and complementary research in different nations.

It is also important for policy-makers to be aware that building an effective stance on international engagement in research does not necessarily require Finance ministries to sanction overseas payments. The essence of effective international cooperation is *reciprocity* – arrangements via which bilateral or multilateral partners deliver reciprocal resources (e.g. host staff and students by bearing their costs *in the host nation*, pay for research instrument and laboratory costs *in the host nation*). It is possible to construct vibrant and productive international cooperation by making it easier for such reciprocal relationships to be established and maintained.

To facilitate this, FEAST has proposed the development of a *'Standard International Research and Innovation Cooperation Agreement'* (SIRICA) template. This generic legal template would be designed to significantly reduce the transaction costs and lead times (and risks) involved in establishing new reciprocity-based bilateral and multilateral cooperation agreements. An effective SIRICA would be a key pathway to greater interoperability in the global research system.

It is significant in this context of reciprocity and interoperability that the European Commission has launched a set of inter-connected projects – ACCESS4EU – that aims to raise awareness of the opportunities for Europe-based researchers to access funding and to collaborate with colleagues in a range of non-European nations.

Projects with this focus, funded by the European Commission, are now underway in Australia, Brazil, Canada, China, India, Mexico, New Zealand, Russia, South Africa, South Korea and the USA. The Australian project is led by the International Bureau of the German Federal Ministry of Education and Research and involves FEAST, CSIRO and the British Council. The various national projects are cooperating over the development of a standard database architecture that aims to make it easier to understand and compare different nations' research funding arrangements. In addition to aligning efforts with those in the other participating countries, the Australian element of the project (led by FEAST) is also carrying out some exploratory work on the potential for developing measures of openness and reciprocity in access to national research funding systems.

I suspect that the ACCESS4EU initiative will end up being rather revealing. Now, domestic funding programme owners tend to assume that only nationals will be scrutinizing their websites and documentation. This means that eligibility criteria for international researchers may not be transparent, tending to be hidden away in technical details. ACCESS4EU stands to play a useful role in drawing attention to the need to make eligibility criteria both transparent and readily identifiable – especially in website design.

Additionally, I suspect it will be revealed just how closed many domestic funding programmes are. Once we have completed our prototype of openness metrics and have tested them against different nations' funding arrangements I expect we will find these arrangements are still pretty insular in terms of the proportion of funding that is open to overseas applicants. Further details of this work-in-progress can be found on pp.142–144.

## Where are we going?

We would like to see:

A distributed NCP network (run via a partnership with another organization/professional association) strongly embedded in university and government agency research offices.

A more formal approach to case management by NCPs in Australia. Ideally, we'd like to see a process where an institution would require an NCP File Number and/or a copy of the completed NCP Case Management checklist before signing off on any FP7 contract.

An effective Policy Hub that interacts with the distributed NCP network: sharing collective information and analysis. What we currently know as FEAST would be split into two distinct functions – and could be managed by distinct (but cooperating) entities.

A wider 'open innovation' process aimed at developing the SIRICA approach and related work on inter-operability with an emphasis on better ways of achieving more nimble (that is to say quick to start, flexible in evolution and easy to exit) and cost-effective bilateral and multilateral cooperation.

To these ends, FEAST is organising a Symposium on Enhancing Interoperability in the Emerging Global Research Order to be held in Brisbane in March 2011. This will be an invitation-only forum for senior policy people, and will provide an opportunity to develop the concept of interoperability in international research projects. I am very pleased to confirm that the University of Queensland has recently agreed to partner with us on this forum. ■

# The history and FUTURE PROSPECTS of FEAST-type units

## An astonishingly rapid genesis

FEAST was created in 2000 through the Australian Parliament on 9 November 2000, just three months after the idea was first suggested by the French Embassy. During those three months, 24 institutions had agreed on the project, including all the European Diplomatic missions in Australia, all major Australian ministerial departments and research operating and funding bodies. The name, the logo, the website and the members database were all designed and implemented during this time, and both the Australian Department of Industry, Science and Resources and the European Commission had announced financial support for operational costs of FEAST.

The first FEAST symposium was held in May 2001. It hosted several hundred participants, including Australian and European researchers, heads of university and research bodies, senior Australian Ministers, Ambassadors and the Director General for Research of the European Commission. Nearly ten years later, FEAST is alive and well and has provided a template for similar organizations in several other countries.

How could this happen? Three main reasons emerge – it was the right proposal made at the right time, then an instigator (the French Embassy) invested the necessary means to develop, implement and manage all that was needed (including website, database and logo). Finally, a small core of four key Australian and European people worked daily to share ideas and relational support.[1]

## The original intuition: the right proposal at the right time

On the Australian side, the white paper on *Knowledge & Innovation* (December 1999), the Australian Research Council's strategic plan (2000-2002), the *Innovation Summit Implementation Group's Report* and the Chief Scientist's discussion papers on the *Science Capability* Review all underlined the importance of the role of international science and technology communication and collaboration. This was an essential activity for the transfer of ideas and knowledge, and crucial for maintaining both world class human capital and economic competitiveness.

In March 2000, a meeting of the joint Management Committee of the European Union and Australia on Science and Technology Cooperation was held in Brussels, within the framework of the 1994 Agreement. One of the decisions made was to start reflecting upon a target-based approach, a strategy and common priorities.

In Europe, the concept of the European Research Area (ERA) had just been launched. This was referred to as "a vision about coordinating national research activities and policies and creating an internal market for research with the free circulation of researchers, ideas and technology."[2]

The original intuition behind FEAST was developed independently from these processes, but it fitted in

> FEAST was based on building and supporting a community of interest, in a time in which this expression was not widely known. Tools and methods can be improved, but the basic intuition is still relevant

Alain Moulet

*Alain Moulet was Science and Technology Attaché in the French Embassy in Canberra from 2000 to 2004. He proposed the idea and contributed to the creation and building of FEAST. He is presently in charge of innovation, competitiveness and information society at DATAR (the Interministerial Delegation for Regional Development and Attractiveness – French Prime Minister's Office).*

perfectly. As often occurs, the origin is linked to circumstances, and here I must narrate a little history in the first person. When I was named Science and Technology Attaché at the French Embassy of Canberra in February 2000, I looked for information about French and Australian researchers engaged in bilateral cooperation. A database did exist in the Embassy, but it was outdated. On the other hand, we had three Australian-French Association for Science, in Canberra, Sydney and Melbourne, managed by volunteers and with different degrees of visibility and activity. On this basis, I decided to embark on creating a real French-Australian network, based on face to face and virtual activities, using the tools that Internet had come able to offer. By chance, France assumed the Presidency of the European Union in July 2000 and it appeared to me that creating an European-Australian network, instead of a simple French-Australian one, would have required about the same tools. Furthermore, the additional cost would have been largely balanced by the increase in support, visibility and global efficiency.

Consequently, the original intuition and proposal was:

- to support and develop European-Australian scientific cooperation building a community of interest;
- to reach all potential members of this community – public and private sector researchers as well as managers in university research bodies, companies, funding organisations and ministries;
- to facilitate both virtual and physical networking by providing Internet tools, supporting regional associations, international thematic networks and workshops or other events, and;
- to address Europe as a single global geographical reality, including both bilateral and multilateral cooperations.

This last and fundamental point was a perfect implementation of the ERA concept. It was new, and led to the realisation that Europe was the first S&T partner of Australia. This was recognised up to a political level, and led to funding and agreement decisions in favour of Australian-European cooperation.

## A lasting initiative, that has become an international template

For over 10 years, FEAST has successfully passed any review or assessment. Several thousand researchers are or have been members of the FEAST network.

As an example of the level of activities, the French-Australian sub-group of FEAST, called *FEAST-France* had, mid-2004, 550 members, 62 liaison officers working in Australian universities and research bodies and 10 in France (all of them officially approved by their organisations), four regional associations – jointly supported by the scientific and economical sections of the French Embassy – in Sydney, Melbourne, Canberra and Brisbane, and thematic research and industry networks on Nuclear Medicine, Bionanotechnology, multi-agent systems applied to ecosystems (not limited to French researchers, and often leading to EC Framework projects, but created by French-Australian initiatives).

Managing these bilateral efforts inside FEAST has benefited the researchers, the French Embassy and the FEAST management office through a shared membership, a single global network, coordination of funding and events, facilitation of expansion of Australian cooperation with France to the whole of Europe, and increased French participation in FEAST activities.

FEAST has been the first ERA-type initiative outside Europe and has been chosen as a template for European international cooperation. A call for proposals was opened by the European Commission and led to FEAST-type units in Argentina, Canada, China, Japan, Mexico, New Zealand, South Africa, Tunisia and the USA. FEAST-type units fulfil an existing need in a modern way, but have to be inscribed in an ERA-based approach and management.

Ten years after the creation of FEAST, researchers still need linkages and knowledge. FEAST was based on building and supporting a community of interest, in a time in which this expression was not widely known. Tools and methods can be improved, but the basic intuition is still relevant.

The most important and sometimes difficult point is the ERA concept. FEAST must not be limited to multilateral cooperation at European Commission level, but include all cooperation with European countries. Activities and governance must be shared and supported by the European Commission and the European Member States. The value of the FEAST-type units resides in their capacity to unite the administrative bodies in charge of bilateral and multilateral support and to address the reality of research, based on various and evolving levels of cooperation.

FEAST is still a very a modern concept, linked to a project goal that is yet to be achieved – Europe as a place where research knows no internal frontiers. ■

FOOTNOTES:

1 I wish to acknowledge and thank the three other members of that team: John Tuckwell (Delegation of the European Commisson in Australia), Graeme Rankin (Australian Department of Industry, Science and Resources) and Rolf Ericsson (Embassy of Sweden, which succeeded France for the Presidency of the EU in January 2001.)

2 Accompanying the Green Paper The European Research Area: New Perspectives {COM(2007)161} European Commission, 4.4.2007

# ENGINEERING AND SPATIAL SCIENCE RESEARCH

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- The Computational Engineering and Science Research Centre (CESRC) is a multi-disciplinary group which has an international reputation for excellence in the development of novel computational methodologies for the solution of unique problems that require very complex modelling.
- CEEFC the Centre of Excellence in Engineered Fibre Composites has an international reputation for pioneering research and development for the application of the fibre composites in civil infrastructure.
- The National Centre for Engineering in Agriculture (NCEA) has strong links with many rural research and development corporations, irrigation stakeholders and private industries within the rural sectors. The centre has an international reputation for applied research in agricultural systems aimed at meeting client and industry needs.

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# THE POWER
## of synergies in research

In the current Global Financial Crisis, governments are likely to consider re-prioritising funding for public science. One area that they should avoid cutting is funding for international research collaboration.

Funding for this area is – of course – vitally important, as coordinated research efforts minimize wasteful duplication and maximize benefits of scale, scope and speed, allowing international research collaboration to play a key role in addressing major challenges such as climate change and energy security. Governments are aware that international research cooperation tends to be more frequently cited (i.e. is more 'productive') than average and often addresses major global challenges to which governments themselves seek coordinated responses via diplomatic channels. Consequently, funding cuts may selectively impact on less competitive areas – the 'slack' in the system.

Partly because of the previous point, international collaboration is increasingly treated as being part of the core mission of research rather than a footnote to it (for example, recent changes made by the Australian Government to ARC, CSIRO, and CRC program funding). Institutions with concentrated excellence-driven research funding (provided it is concentrated on the basis of excellence) are well positioned to fund collaboration with international peers as part of the 'core business' of doing their research. In many areas of research there is tremendous potential to link, and therefore exploit, the synergies between existing research programs. Indeed, the research proposals that score well in peer-review funding allocation mechanisms frequently contain an international collaboration dimension.

Since the early 1970s – and for obvious political reasons – Europe has led the way with COST Actions, which are mechanisms for exploiting useful synergies between existing national research projects (see www.cost.esf.org). The idea behind COST Actions is to fund the additional transaction costs associated with researchers coordinating their research, sharing results and developing generic tools and methods (such as formal standards) that have collective benefits. Particularly during times of budget cutbacks, these research coordination and synergy-based 'actions', with their potential to leverage the research we are already funding, and to do this internationally, are a useful model for sustaining international research collaboration. In other words, funding the international coordination transaction costs is a cost-effective leverage mechanism.

The low risk strategy for researchers seeking to sustain international collaboration during the Global Financial Crisis is to prosecute a two-pronged approach of:

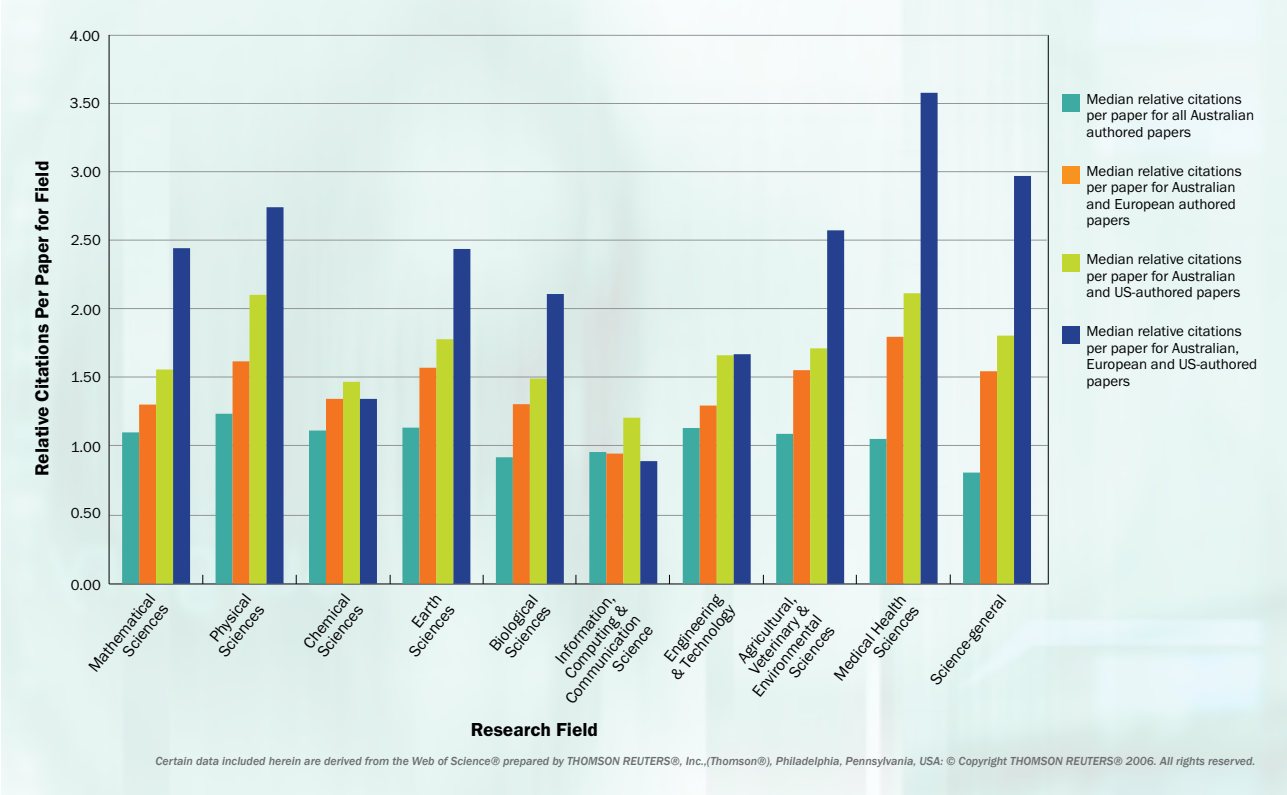
a) treating international cooperation as integral to research rather than an optional extra (i.e. absorbing the transaction costs internally); while also

b) seeking to develop elective multilateral mechanisms for linking together and exploiting the synergies between existing research programs in different nations.

These approaches are not new, they are already well-established best practice for effective research teams – they provide a basis for 'self-reliant' approaches to international research collaboration. By mainstreaming international collaboration in the core business of research in this way, without the necessity of accessing (always limited) dedicated funding for international collaboration, a sustainable operating model is possible.

For Australian researchers, a major advantage of this approach is that as potential partners they are of lower risk for prospective overseas collaborators. There is (by intent) no need to rely on additional targeted external funding to actually collaborate internationally, which avoids familiar pitfalls experienced when relying on (hard to get) additional funding. This ➤

> "institutions with concentrated excellence-driven research funding … are well positioned to fund collaboration with international peers as part of the 'core business' of doing their research"






statistics on the funding allocated by governments to support international research cooperation by no means reflect the real importance of research cooperation – just the tip of the iceberg

is a particular advantage in collaborations with researchers in the EU's Seventh Framework Programme (FP7) because Australian participation in FP7 is hard for those that rely on dedicated external funding. An additional advantage is that leveraging existing research via international cooperation allows assessing and learning how to manage the particular types of risk faced in such collaborative work. This in turn places Australian researchers in a better position to make the best use of any additional dedicated funding that may become available to support international collaboration in the future – based upon a demonstrated track record of success.

Not surprisingly, this self-reliant model is already well-established. It means that statistics on the funding allocated by governments to support international research cooperation by no means reflect the real importance of research cooperation – just the tip of the iceberg. Partly for this reason FEAST has started to map patterns of international research collaboration by tracking the incidence of internationally co-authored publications. FEAST's Discussion Papers examining these issues are free to download.

The initial results of this mapping work (using Thomson-Reuters citation data) indicate that whilst bilateral collaboration between Australia located and Europe located authors is associated with improved citation rates, in most research fields multilateral collaboration that also includes US-based researchers is associated with even better citation performance[1]. This can be grasped in the figure above.

This pattern applies to most research fields (note, however, that results for Information, Computing and Communication Science are not robust because these areas are not well covered by this data source).

Perhaps it is time to look into designing innovative new multilateral mechanisms for coordinating and exploiting the synergies between existing research – worldwide. Whilst the cooperation architecture and associated governance challenges would be significant, the ability to sustain international research cooperation in key thematic areas during the financial crisis is a pretty useful outcome.

*Dr Mark Matthews, FEAST*

This article first appeared in Australian R&D Review

FOOTNOTE:

1 One caveat to this initial finding is that it is necessary to distinguish between the impact of an increased number of authors on citation performance (which can in itself increase citations irrespective of international collaboration) and the specific impact of multilateral international joint authorship. Further work is underway at FEAST examining this issue.

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# CSIRO – managing Australian treasures

Did you know that CSIRO manages three major national research facilities: The Australian Animal Health Laboratory, the Australia Telescope, and the research vessel *Southern Surveyor*?

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# AUSTRALIAN-EUROPEAN cooperation in action

Here four case studies illustrate the ongoing research made possible through Australian-EU collaboration.

ABOVE: Wind-powered turbine at the CSIRO Energy Centre, Newcastle, NSW. *Photo by: CSIRO Energy Technology*

RIGHT: Construction of wind powered electricity generators at Crookwell, NSW. *Photo by: Gregory Heath*

## GMSAFOOD

The function of post-market monitoring is to further assess possible nutritional and health effects of authorised GM foods on a mixed population of human and animal consumers. Currently, however, little is known about exposure levels, whether adverse effects are predictable, and the occurrence of any unexpected effects following market release of GM foods. Our objective is to identify a panel of anatomic, physiologic, biochemical, molecular, allergenic, and immunogenic biomarkers, which could be used to predict harmful GMO effects after product authorisation. Using a prototype allergenic a-amylase inhibitor GM-pea, we will extrapolate multiple biomarker databases that correlate GMO effects during gestation, growth, maturation in various animal models with humans. We will establish biomarkers in GMO-fed pigs, salmon, rats, and mice, in addition to indirect effects of GM feeding in the food chain and GMO influence during an underlying allergic disorder. These experiments will yield data on general health with a specific focus on allergy and immunology. To extrapolate our data to humans, we will establish a comparative database with antigenic epitopes and antibody crossreactivity in legume allergic patients and human-mouse chimera, in which a human immune system is transplanted into a mouse lacking an immune system. Taken together, these results will yield databases from multiple biological systems that will be used in a mathematical modelling strategy for biomarker discovery and validation. Our consortium consists of partners from Austria, Turkey, Hungary, Ireland, Norway, and Australia and constitutes a diverse interdisciplinary team from veterinary medicine, nutrition, agriculture, immunology, and medicine. It is dedicated to the development and validation of biomarkers to be used for post market monitoring of animals and humans consuming newly authorized GMOs.

At a recent meeting in Brussels, the partners, including Australia, each reported on progress on their own components of the project. Dr Higgins has supplied plant material and biochemical information on the protein being studied. The genetically modified plant protein has now been fully characterised and the team is in the process of studying its effect in various animal species.

*Contact: Dr TJ Higgins, Honorary Fellow, CSIRO Plant Industry*
TJ.Higgins@csiro.au.
*For more information visit* www.gmsafood.org

## Safewind

The integration of wind generation into power systems is affected by uncertainties in the forecasting of expected power output. Misestimating of meteorological conditions or large forecasting errors (phase errors, near cut-off speeds, etc) are very costly for infrastructures (e.g. unexpected loads on turbines) and reduce the value of wind energy for end-users. The state-of-the-art in wind power forecasting focused so far on the "usual" operating conditions rather than on extreme events. Thus, the current wind forecasting technology presents several strong bottlenecks. End-users urge for dedicated approaches to reduce large prediction errors or predict extremes at local scale (gusts, shears) up to a European scale as extremes and forecast errors may propagate. Similar concerns arise from the areas of external conditions and resource assessment where the aim is to minimize project failure.

The aim of this proposal is to substantially improve wind power predictability in challenging or extreme situations and at different temporal and spatial scales. Going beyond this, wind predictability is considered as a system parameter linked to the resource assessment phase, where

the aim is to take optimal decisions for the installation of a new wind farm. The project aims to develop:

- new measuring devices for a more detailed knowledge of the wind speed and energy available at local level;
- strong synergy with research in meteorology;
- new operational methods for warning/alerting that use coherently collected meteorological and wind power data distributed over Europe to early detect and forecast extreme events;
- models to improve medium term wind predictability;
- a European vision of wind forecasting taking advantage of existing operational forecasting installations at various European end-users.

Finally, the new models will be implemented into pilot operational tools for evaluation by the end-users in the project.

Dr Alberto Troccoli of CSIRO's Wind Energy Research Unit is working with colleagues from a number of European organisations, including industrials such as Transmission Systems Operators (TSOs), utilities and wind farm developers to tackle some of the issues above in an Australian context.

*Contact: Dr Alberto Troccoli of CSIRO Marine and Atmospheric Research,* alberto.troccoli@csiro.au.
*For more information visit* www.safewind.eu

## Best-practice sheep production

The Australian sheep industry exists primarily to supply export markets. The nature of those markets has been changing and consumers now question industry practice and demand products that are 'clean, green and ethical'. A vision for novel methods of animal management has been a fundamental driver of collaboration between the University of Western Australia (UWA) and l'Institut National de la Recherche Agronomique (INRA) in Tours, France, that began in the 1970s and flourishes to this day.

In the pursuit of clean (hormone-free) management, scientists in the two countries have been working together to study brain systems that regulate ovulation and sexual behaviour. With respect to *ethical* management, the scientists focussed primarily on mother-young bonding and its role in lamb survival. This work was begun 30 years before consumers started demanding ethical products and has produced, at UWA, a unique flock of sheep that has been genetically selected for 20 generations for calm or nervous temperament, a core resource for current collaboration.

The continual development of research projects over 40 years, matching the evolving needs of industry, was only possible because of an enduring close partnership between UWA and INRA. Sheep industries in both countries are being transformed by these efforts and the rate of transformation is accelerating as the vision for 'clean, green and ethical' production is strengthened and promoted around the world. Australia and France are seen as leaders, not followers, in the development and pursuit of this vision.

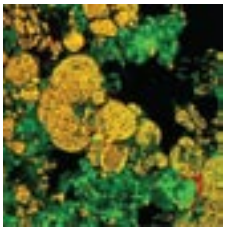
*Winthrop Professor Graeme B. Martin BSc(Agric) PhD*
*UWA Institute of Agriculture*
*For more information visit* http://www.ioa.uwa.edu.au/

## Improved treatment of industrial wastewater

Conventional wastewater treatment plants use a microbial process to degrade and remove pollutants from wastewater so that the treated water can be reused or discharged safely into the environment. Wastewater treatment plants based on aerobic granular sludge represent an innovative alternative. They have a higher treatment capacity due to an increased settling capability (Fig. 1) and generate much less waste biomass than conventional processes. Additionally, the conversion to a granular system will allow for a 25 per cent reduction in treatment plant space. The mechanisms that create the conversion from conventional to granular systems are not yet known and are required for the reliable implementation of the aerobic granular sludge technology to wastewater treatment.

Increased settling capability of granules (right cylinder) compared to conventional floccular sludge (left cylinder).

4 seconds 21 seconds 100 seconds



This is fluorescence in situ hybridization (FISH) image depicting polyphosphate accumulating organisms (PAO) in yellow and all other bacteria in green, within aerobic sludge. The PAO organisms are a group of bacteria responsible for removing phosphate from wastewater.

This project continues to develop and demonstrate innovative aerobic granular sludge systems and molecular biological diagnostic procedures to provide economical, streamlined industrial wastewater processes. It has focused on the treatment of abattoir wastewater considered a nutrient rich wastewater.

This technology attracts great interest from the industrial sector because it allows more biomass to be maintained in a relatively small reactor volume, enhancing the ability of the reactor to withstand high loading rates.

The Advanced Water Management Centre (AWMC), at The University of Queensland, is a major partner in this project and collaborates with two leading European Union organisations; Instituto di Ricerca Sulla Acque (IRSA), Rome, Italy and the Technical University of Delft, in The Netherlands. In Australia, the AWMC collaborates with Meat and Livestock Australia (MLA) and with the Environmental Biotechnology Cooperative Research Centre.

The AWMC is at the international forefront in wastewater research and continues to maintain strong linkages with Australian and European expertise both in knowledge and practical application.

*J. Keller , A. Cook., M. Pijuan. and S. Watts.*
*The University of Queensland, Advanced Water Management Centre, QLD 4072, Australia. For more information visit* www.amwc.uq.edu.au

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- a new type of solar material that is more efficient in harvesting sunlight, costs less to produce, and has the potential to speed up Australia's transition from a fossil fuel economy to a renewable energy economy
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*Photo: Professor Ian Frazer, Director of the Diamantina Institute at The University of Queensland and co-developer of the world's first cervical cancer vaccine*

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# AUSTRALIA'S COMPARATIVE PERFORMANCE in international research collaboration for science and technology

International collaboration allows important synergies between expertise, geographical circumstances and research facilities/instruments to be exploited – in so doing increase the rate of progress made in research and the more timely diffusion of the eventual benefits that arise.

Australia's credibility and international standing is enhanced by being seen to play an active and proportional role in international efforts to address major global challenges requiring research inputs. This, in turn, generates a wide range of diplomatic benefits as a direct consequence of not being seen as a 'free rider' in the international cooperative research system.

## Benefits

As mentioned, effective international engagement can provide many benefits to a nation and its researchers. These advantages include access to leading international research facilities and data sets that Australia does not possess, and in many cases would not be able to afford, and access also to geographical circumstances that do not exist in Australia e.g. glaciers, the northern skies. International collaboration enables the exploitation of scale and scope in research projects that are not possible with national projects alone, along with a lower incidence of duplication and waste in research efforts. Early access to results and insights arising from collective international research efforts allow for their timely application here.

The interpersonal relationships between researchers and students that stimulate worldwide collaboration contribute to transfers of knowledge, skills and personnel and to success in international funding programs.

Publications stemming from internationally collaborative research tend to be more highly cited than research with no international collaboration. Furthermore, multilateral collaboration is associated with a higher 'citation impact multiplier' than bilateral collaboration. This generates an increased impact for Australia's researchers from a wider dissemination of their findings, and may contribute to improved international rankings for our universities.

## Current International S&I Engagement and Output Patterns

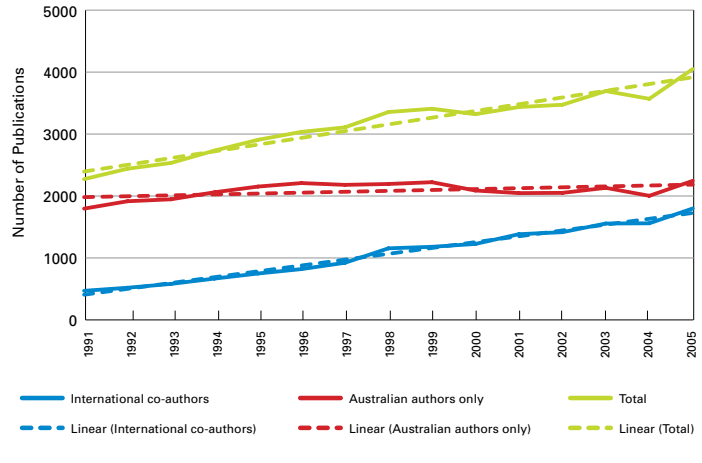
Governments worldwide face the challenge of how best to prioritise their international science and innovation (S&I) cooperation activities. This involves balancing the intrinsic benefits that arise from international S&I collaboration as outlined above with extrinsic considerations such as diplomacy, trade and national security. This is particularly important for small to middle range countries such as Australia.

Given the advantages, it is natural for governments seeking to maximise productivity in academic research to focus on the measured benefits. One element of this productivity is the impact of the resulting publications on peers and other knowledge users. We can assess this impact using the rates at which these publications are cited and so give an indication of quality. We can also use publication data to map patterns in Australia's international collaboration.

Fields of research vary in the extent to which journal publications reflect the total publication output. Bibliometric analyses using journal-based datasets are problematic in some research fields, particularly disciplines in the applied sciences, social sciences and humanities. Much of the research in these fields is not published in journal articles, and even when output is journal-based, the capture rate in data indices can be incomplete. For our analysis, we have used data derived from Thomson Reuter's *Web of Science* (WoS)[1].

One measure of capabilities is the Relative Citation Impact (RCI), the citations per paper divided by the world average, which indicates the extent to which a group of publications deviate, upwards or downwards, from the average for that field of research. This measure is used here to look at the impact of collaboration with Europe, the European Union (EU) and the United States. ➤

FIGURE 1 International Collaborations in Australian Publications, 1991-2005




*Source: Web of Science Citation Index*[1]

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Evidence-Based Medicine is a significant area of health and medical research in contemporary Australia. Bond University has a critical mass of primary care researchers including Professor Chris Del Mar, Professor Jenny Doust and Professor Mieke van Driel. The primary focus of these internationally renowned academics is on Evidence-Based Medicine theory and practice.

Professor Paul Glasziou, a recipient of the prestigious NHMRC Australia Fellowship, will also join Bond University in July to undertake research into the processes and implementation of Evidence-Based Medicine. Professor Glasziou's research will help to more intelligently and efficiently close the gaps between best available evidence and current clinical practice.

## STEM CELL RESEARCH

Dr Patrick Warnke's extensive research portfolio encompasses dentistry, maxillofacial surgery, plastic surgery, stem cell research, bone grafting, tissue engineering and other health-related issues. The results of his findings have been published in numerous peer-reviewed international journals and texts and presented in over 100 scientific presentations.

For further information about his research in growing replacement human joints, visit **www.myjoint.org** or contact Dr Patrick Warnke at **pwarnke@bond.edu.au.**

## CHRONIC FATIGUE SYNDROME

Dr Sonya Marshall is one of Australia's foremost researchers in the area of neuroimmunology and has been instrumental in establishing the Public Health and Neuroimmunology Unit (PHANU) at Bond University.

Much of Dr Marshall's work relates specifically to autoimmunity in Chronic Fatigue Syndrome sufferers. Consequently, she is regularly asked to speak to community groups on behalf of Queensland Health and New South Wales Health. Her research in the area of exercise immunology has also contributed to the body of knowledge relating to the effect of doping in sport and she serves as Sports Medicine Australia's national spokesperson in this area.

The vital research conducted by Dr Marshall has attracted more than $1 million in grant funding and she has produced 21 peer-reviewed papers, five book chapters and one provisional patent.

## UROLOGY RESEARCH

In 2009, Professor of Physiology Russell Chess-Williams was awarded funding from the National Health and Medical Research Council (NHMRC) for a three-year urology research project investigating bladder function. As the chief investigator of the project, Professor Chess-Williams will lead an international team of researchers to study chemical processes involved in patients suffering from an over-active bladder and the health issues this condition causes.

## SUSTAINABLE HEALTHY COMMUNITIES

Bond University's Institute of Sustainable Healthy Communities, led by Professor George Earl, aims to develop knowledge and awareness of the interrelationship between planning practice, property development and environmental, social and economically sustainable development and design.

Professor Earl is a leading advocate of sustainable development and aligns environmental values with economic, physical and social needs. His expertise in this field is evidenced by over $3.6 million worth of research grants funding in-depth studies into the needs of specific demographic groups such as aged care residents, indigenous communities and low income rental housing.

Bond University Associate Dean of Research and Professor of Construction and Facilities Management, Dr Craig Langston, is also currently first chief investigator of an Australian Research Council (ARC) Linkage Project investigating the strategic assessment of building adaptive reuse opportunities. He is also chief investigator on another ARC Linkage Project titled 'Making Better Decisions about Built Assets'. Dr Langston has successfully supervised five PhD candidates, and a large number of honours students. He has published five books, six book chapters and over twenty refereed journal papers in the last ten years.

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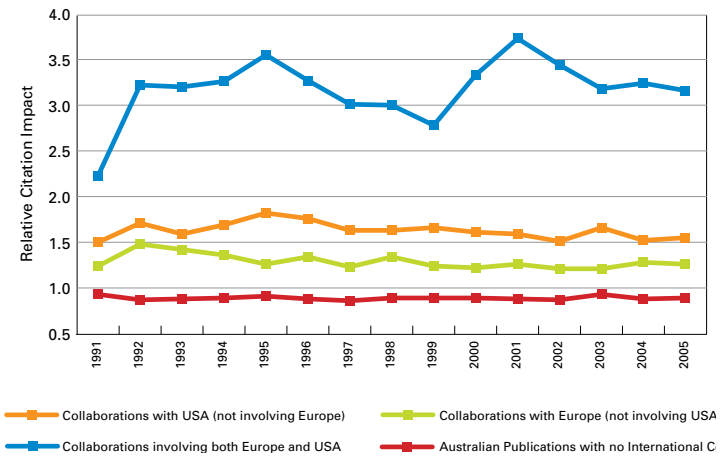
Most of the growth in Australia's research publications is associated with international collaboration rather than purely domestic efforts. The proportion with international co-authorship has increased from almost 21 per cent in 1991 to over 44 per cent of total publications in 2005.

**FIGURE 2 Relative Citation Impact of Science Publications, 1991-2005**




*Source: Web of Science Citation Index*[1]

In mapping relative citation rates for collaboration between Australian based researchers and those from Europe and the United States, we see that multilateral collaborations yield significantly higher performance.[2] These results suggest that there is a clear incentive to pursue bilateral collaboration with European researchers and an even stronger incentive for Australian located researchers to collaborate multilaterally with European and US-based authors. This is further evidence for an increased proportion of national research funding being made available for international research collaboration.

**FIGURE 3 Science and Innovation Cooperation Pay-off Matrix**

| | EU-27 Strengths Relative Citation Impact > 1.1 | EU-27 Borderline Relative Citation Impact 0.9-1.10 | EU-27 Weaknesses Relative Citation Impact < 0.9 |
|---|---|---|---|
| Australian Strengths Relative Citation Impact > 1.1 | Geosciences<br>Physics<br>Plant & Animal Science | Clinical Medicine<br>Ecology/Environment<br>Education<br>Mathematics<br>Space Science | |
| Australian Borderline Relative Citation Impact 0.9-1.1 | Agricultural Sciences | Biology & Biochemistry<br>Chemistry<br>Computer Science<br>Engineering<br>Immunology<br>Materials Science<br>Microbiology<br>Molecular Biology & Genetics<br>Multidisciplinary Science<br>Neurosciences & Behaviour<br>Pharmacology<br>Psychology/Psychiatry<br>Social Sciences, general | |
| Australian Weaknesses Relative Citation Impact < 0.9 | | | Economics & Business<br>Law |

*Source: Web of Science National Science Indicators*[1]

## Policy Issues

Given the limited financial resources available to support international S&I cooperation, it is useful for policy makers to have appropriate information upon which to base their decisions. One way of thinking about international collaboration is in terms of potential pay-offs and associated risks, along with an indication of bilateral imbalances in research performance.

This framework can distinguish *forge ahead opportunities*, where both parties are currently strong performers; *pull-up opportunities* and *pull-down risks*, where one party is a strong performer and the other weak, and *catch-up opportunities* in which both parties are weak performers.

This example provides a useful profile of the European Union and Australia's research competitiveness and potential areas for productive collaboration. There are three fields – geosciences, physics and plant and animal sciences – in the *forge ahead opportunities* quadrant and two – economics and business and law – in the *catch-up opportunities* quadrant.

In looking more closely at individual EU countries and the United States, it is apparent that Australia's relative performance is generally fairly strong to moderate – but rarely outstanding. Perhaps more significantly, it shows that relatively small nations in terms of population, share of global R&D and of global GDP can and do perform relatively well as measured by RCI. These are nations that exploit advantages of niche capabilities in which they excel and address distinctively national objectives linked to geography and comparative advantage – both natural and knowledge-based.

This means that Australia may have the most to gain from enhancing its S&I cooperation with the smaller EU member states in the 'greater' Scandinavian region. If combined with Canada and the United States, cooperation could provide the basis for productive multilateral engagement in areas of key policy importance to Australia.

*Kerrie Glennie, FEAST*

*This article is a synthesis of two FEAST Discussion Papers – A Bibliometric Analysis of Australia's International Research Collaboration in Science and Technology: Analytical Methods and Initial Findings, www.feast.org/index/document/1*
*A Comparison of Australian and European Union Research Performance Profiles, www.feast.org/index/document/2*

FOOTNOTES:

1 Certain data included herein are derived from the Web of Science® prepared by THOMSON REUTERS®, Inc., (Thomson®), Philadelphia, Pennsylvania, USA: © Copyright THOMSON REUTERS® 2006. All rights reserved.

2 One caveat to this initial finding is that it is necessary to distinguish between the impact of an increased number of authors on citation performance (which can in itself increase citations irrespective of international collaboration) and the specific impact of multilateral international joint authorship. Further work is underway at FEAST examining this issue.

# THE ROLE OF NATIONAL SCIENCE AGENCIES in addressing major global challenges and opportunities

As Australia's national science agency, CSIRO recognises that active global engagement is critical to its ability to deliver both excellent science and social, environmental and economic impact from this science. This will only become more pronounced as we face the major challenges and opportunities for Australia and the globe in the coming years.

As researchers and citizens, we face the reality that we are all connected. We all want a prosperous and healthy society, but we face significant challenges, such as securing our food, water and energy needs in a world of finite resources. We are experiencing significant pressures on global systems, for example population growth, rapid urbanisation and climate change.

These national and global issues are connected. They cannot be dealt with in isolation. Individuals, communities, industries and nations are seeking to understand this connectivity and the inevitable trade-offs necessary to achieve a sustainable society.

CSIRO's strategy remains to focus our scientific efforts on these major challenges and opportunities that face our nation and humankind.

As a relatively small part of a globalising system, Australian science needs to be connected to peers worldwide to ensure that it is of the highest quality and up-to-date with new knowledge.

Similarly, in seeking to create impact from its science in line with Australia's national interest, CSIRO understands that this requires international awareness and engagement, because:

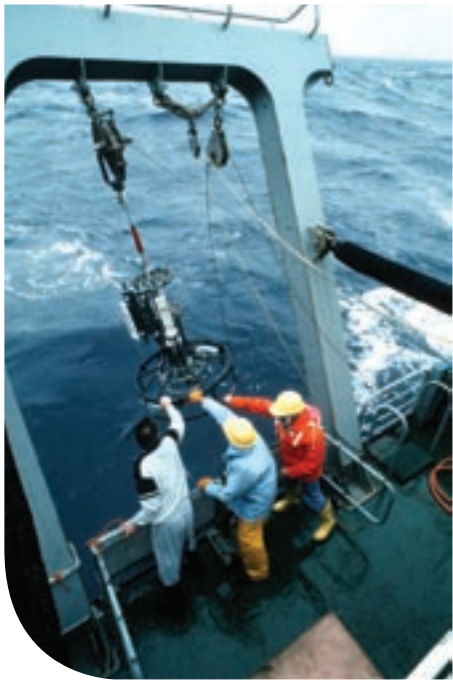
- the Australian community is intricately linked to the broader global population
- Australian industry operates within the global market and economy
- many of the major environmental issues facing Australia are truly global in nature.

Over recent years, CSIRO has had a clear strategic focus on strengthening select international partnerships. This has included specific initiatives to build upon decades of successful collaboration with European partners. Ensuring that this collaboration is strengthened into the future – both bilaterally and multilaterally – will be crucial for CSIRO in its continued delivery of science and impact.

CSIRO's history of significant collaboration with partners in countries such as the UK, Germany, France, the Netherlands and Italy is broadening into new, integrated multilateral efforts to address key challenges. For example, CSIRO's long-term collaboration with the Hadley Centre at the UK Met Office has been central to the development of next generation weather and climate prediction systems for Australia and also involves partners in France and the United States.

CSIRO is also a founding member of the Global Research Alliance, which includes its peers in Europe – the Fraunhofer

The retrieval of a CTD, a sampling device which collects data on conductivity (salinity), temperature and depth. Credit: CSIRO Marine Research
The retrieval of a CTD, a sampling device which collects data on conductivity (salinity), temperature and depth.
*Photo by: CSIRO Marine Research*



> individuals, communities, industries and nations are seeking to understand this connectivity and the inevitable trade-offs necessary to achieve a sustainable society

Dr Megan Clark, Chief Executive Commonwealth Scientific and Industrial Research Organisation (CSIRO)

Gesellschaft in Germany, VTT in Finland, TNO in the Netherlands and the Danish Technological Institute. The aim of the GRA is to leverage the scientific capabilities of its members – nine of the leading applied research organisations around the world – to contribute to the meeting of the Millennium Development Goals.

One area in which CSIRO is building upon traditional links with Europe with new forms of collaboration is food and sustainable agriculture – working with partners in the research community, in government and in industry to take an integrated approach to complex challenges and opportunities.

In the next 50 years, we will need to produce as much food as has been consumed over our entire human history. Humans have met this challenge once before – from 1960 to 2000 the world doubled its food production through a combination of new technology and investment in agriculture. But this time we will need to achieve this in a world where water and carbon will have a price and in which rapid urbanisation is taking place.

Our ability to respond to these inter-related sustainability challenges will rely upon global collaboration for the science and data required, as well as partnerships to deliver change.

CSIRO is in the top one per cent of institutions in the world in 14 of the 22 ISI fields of research, and in plant and animal sciences, agricultural sciences and environmental science/ecology, CSIRO ranks within the top 10 of research institutions worldwide. In these fields we have built up strong partnerships with European colleagues over many years.

Over the last couple of years, we have developed new approaches to collaboration with European partners in food and agricultural research to increase the quality and impact of our science.

CSIRO received support from the Australian Government Department of Innovation, Industry, Science and Research to pilot a new "twinning" program with the EU's 7th Framework Programme in food and agricultural research. This links relevant CSIRO programs with the multilateral, multi-disciplinary programs in FP7 to derive increased benefit from the alignment of complementary research efforts in different countries. Our scientists are deepening their collaboration and knowledge exchange in areas such as the nutritional and structural designs of foods for health benefits, as well as bioactive ingredients and new biomaterials in food.

CSIRO has also recently established a new partnership with Bayer CropScience to develop high yield cereals and to assess their sustainability in the face of global environmental and food security challenges.

To help Australian companies compete globally, we need to know what it takes to be globally competitive.

In this connected world, science needs to work on challenges that face all nations to secure a future for humankind. Only then can we secure a future for Australia. ■

> "in the next 50 years, we will need to produce as much food as has been consumed over our entire human history"

**The CSIRO is in the top 1% of institutions in the world in 14 of the 22 ISI fields of research**

CSIRO and Bayer CropScience are collaborating on a new two-year research program designed to assess the sustainability of new generation crops. *Photo by: CSIRO Marine Research*





# The Western Australian Museum

is leading the way in new species identification, authoritative research and collection and preservation of the State's cultural and scientific heritage.

The WA Museum was established in 1891 and today maintains and manages the State's collection of 4.4 million objects, including faunal, palaeontological, mineralogical and meteoritic specimens.

Since 2007, Museum staff have described 208 new animal taxa, 1 new mineral species, 31 new meteorites and 21 new fossil taxa. In addition, this research informs debate on environmental priorities such as introduced pests, sustainability, and climate change.

The Museum's team of specialised scientists work closely with proponents, industry partners, consultants and government agencies regarding the conservation and sustainability of biodiverse, geodiverse and culturally significant areas.

The Museum provides objective, authoritative information and advice to Government and the private sector on the State's faunal and cultural heritage, assessing the potential impacts of mining, oil and gas and other developments.

This work continues to be a significant and growing contribution by the Museum to the State's development.

The WA Museum aims to advocate knowledge about the collections and communicate it to a wide range of stakeholders through a dynamic program of exhibitions and publications.

WESTERN AUSTRALIAN museum

Images: 1. *Conopea sp.* – This undescribed archaeobalanid species occurs on colorful gorgonians in the Dampier Archipelago © Clay Bryce, WA Museum 2. Curator of Molluscs at the WA Museum, Shirley Slack-Smith, amidst gorgonian fans and sponges in the sponge garden habitat © Clay Bryce, WA Museum 3. Richenda Pral, department of Maritime Archaeology with *Batavia* "Bellarmine Jugs" (detail) © WA Museum 4. Making resin casts of fiddler crabs burrows on the salt flats behind the mangroves can be a hot and sticky job © Melissa Hewitt, WA Museum 5. Diana Jones, WA Museum and Don Voelte, Woodside Energy Limited in the Amazing Archipelago Marine Gallery, WA Museum – Perth © WA Museum

**www.museum.wa.gov.au**

# Australia is in the Southern Hemisphere!

The Australia Telescope Compact Array has been equipped with sensitive receivers enabling it to detect radio waves as short as 3.5 millimetres. The new receivers incorporate special CSIRO-designed chips, made of the high-performance material indium phosphide. The new systems mean that the Compact Array will be the only set of telescopes in the southern hemisphere operating at these short wavelengths until the Atacama Large Millimetre Array telescope in Chile becomes operational at the end of this decade. *Photo by: David Smyth, Source – CSIRO Division, Australia Telescope National Facility*

Australia's science and innovation policy has evolved with only a passing reference to a critical fact – we are the major science power in the Southern Hemisphere. For a long time we have been focused rather too heavily on a science and innovation "cultural cringe". We aspire to be a player in major global advances (like nanotechnology) in which the relatively small scale of our economy pretty much guarantees that we will be a bit player in the wider drama – albeit a good bit player. We talk about the "tyranny of distance" as a liability in our relationship with the ferment of R&D taking place in the Northern Hemisphere. In so doing we draw attention to our relative weaknesses as a player in the Northern Hemisphere science and innovation game.

Rarely do we play our trump card – as we are currently trying to do in relation to the Square Kilometre Array (SKA) radio telescope. Australia stands out in the Southern Hemisphere as possessing a long-standing and well-regarded critical mass in Southern Hemisphere-specific public science – in the environment, astronomy, oceanography, geology, biology, climate change, meteorology, atmospheric processes and, of course, Antarctic research.

> Australia is perfectly placed to articulate a more active and very high-profile 'stewardship' role in championing and coordinating research efforts in the Southern Hemisphere – and on behalf of all nations

The Southern Hemisphere plays a major role in global climate change – there is a lot of ocean, atmosphere and ice, and relatively little land. All this needs monitoring and analysing in order to understand the future of the planet as a whole. The Northern Hemisphere science powers spend significant sums of research money in this domain – but so do we in relative terms.

All this means that Australia is perfectly placed to articulate a more active and very high-profile 'stewardship' role in championing and coordinating research efforts in the Southern Hemisphere – and on behalf of all nations. This stewardship role has important implications for our strategies toward international engagement in science. It requires us to foster better international coordination of research in the Southern Hemisphere and to seek a leadership role in dealings with the north. To date, little emphasis has been placed on this aspect of scientific diplomacy.

Finally, we should not forget that the Southern Hemisphere factor has, and will always play, a key role in Australia's industrial innovation. For example, we have a strong lineage in microprocessor design capability (reflected in new ICT business formation) that has its roots in inter-disciplinary graduate training in 1960/70s radio astronomy. The prescience demonstrated by CSIRO at that time was that graduate training in radio astronomy, closely integrated with electronic engineering (astronomers needed to design their own custom signal processing chips at that time), would generate a generic capability of strong future relevance to industry. This is indeed what happened. There are a raft of (initially Australian) companies started and run by people trained in that interdisciplinary environment within radio astronomy.

The impetus from radio astronomy was there because we play this key role in Southern Hemisphere research.

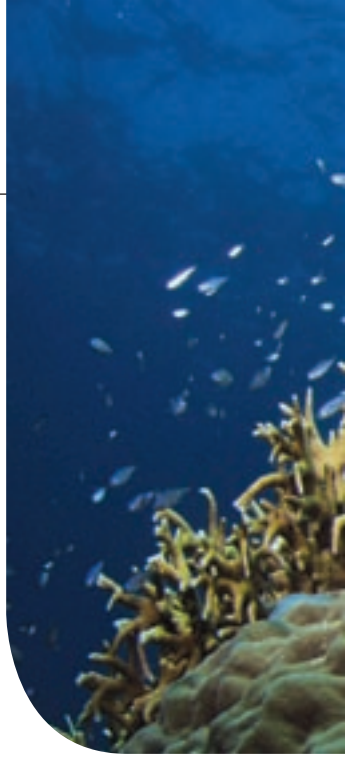
Thus, when we recognise our locational advantages, and set out to actually exploit these advantages, we really do get somewhere in both science and innovation. Current developments in location-finding satellite-using technologies (known as GNSS) are a major opportunity for Australia in this context. A more geographically aware policy framework will help to stimulate potentially lucrative technological applications developed to help us to manage natural and people-made processes in the vast emptiness of the Southern Hemisphere (on land, on the ocean, on the ice and in the air).

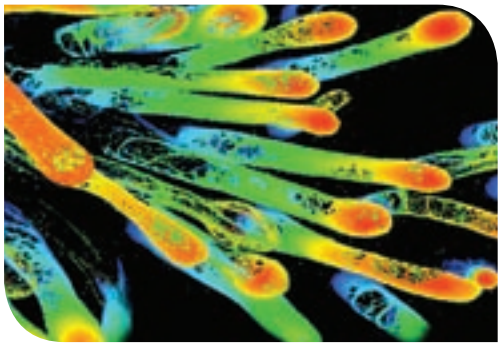
The Federal Government would be wise to articulate a distinctively Southern Hemisphere "aware" science and innovation policy, particularly with regard to international engagement. Let's not ignore a key natural comparative advantage.

*Dr Mark Matthews, FEAST*

This article first appeared in the Australian R&D Review

# FUNDING world-class research teams





LEFT: The ARC Centre of Excellence for Integrative Legume Research is trying to find out more about the relationship between plant and bacterium through the study of plant root hairs. *Photo courtesy of Dr Michael Sheahan,* **ARC Centre of Excellence for Integrative Legume Research.**

*The Australian Research Council (ARC) Centres of Excellence* scheme brings together outstanding researchers of all levels, and enables them to form world-class, internationally competitive research teams.

ARC Centres of Excellence are typically funded over a period of up to seven years, allowing them the flexibility to undertake comprehensive research programs that tackle Australia's big challenges, as well as short-term projects that answer emerging issues or questions.

The long-term funding coupled with the prestigious reputation of the ARC Centres of Excellence title, mean that ARC Centres of Excellence become magnets for the world's most talented researchers.

These best and brightest minds not only enrich the ARC Centre of Excellence and further its excellent research; they enrich Australia and the communities they move to.

The *ARC Centres of Excellence* scheme also promotes a high level of national and international collaboration. Each Centre collaborates with partners from the university sector and other organisations around the globe, facilitating international knowledge transfer that greatly enhances their research outcomes.

The *ARC Centres of Excellence* scheme began in 2002 with the first cohort of Centres being funded from 2003.

On 16 July 2010, the ARC released the funding outcomes for the third round of the *ARC Centres of Excellence* scheme. As a result, 13 new ARC Centres of Excellence are being established in 2011. They are:

- ARC Centre of Excellence for All-sky Astrophysics
- ARC Centre of Excellence for Climate System Science
- ARC Centre of Excellence in Cognition and its Disorders
- ARC Centre of Excellence for Core to Crust Fluid System
- ARC Centre of Excellence for Engineered Quantum Systems
- ARC Centre of Excellence for Environmental Decisions
- ARC Centre of Excellence for Geotechnical Science and Engineering
- ARC Centre of Excellence for the History of Emotions
- ARC Centre of Excellence for Particle Physics at the Tera-Scale
- ARC Centre of Excellence in Plant Cell Wall Biology

The ARC Centre of Excellence in Vision Science's research into how fiddler crabs perceive their world and respond to it is expected to assist in the design of better machine vision for robots.

- ARC Centre of Excellence in Population Ageing Research
- ARC Centre of Excellence for Quantum Computation and Communication Technology
- ARC Centre of Excellence for Ultrahigh Bandwidth Devices for Optical Systems

Together these Centres will receive $255.9 million over seven years to address priority areas such as: Australia's environmental sustainability; the health and wellbeing of Australians; and the future of Australian industries.

Currently, the ARC is providing funding for 24 ARC Centres of Excellence. These 24 Centres are part of two cohorts – those funded from 2003 and those funded from 2005.

ABOVE: Reef scape with large porites in the foreground, northern Great Barrier Reef. The ARC Centre of Excellence for Coral Reef Studies undertakes integrated research for sustainable use and management of coral reefs.

A method called 'girdling' is used to control how signals travel through the plant at the ARC Centre of Excellence for Integrative Legume Research.

The 2005 cohort consists of 11 Centres:

- ARC Centre of Excellence in Antimatter-Matter Studies
- ARC Centre of Excellence in Coherent X-ray Science
- ARC Centre of Excellence for Coral Reef Studies
- ARC Centre of Excellence for Creative Industries and Innovation
- ARC Centre of Excellence in Design in Light Metals
- ARC Centre of Excellence for Electromaterials Science
- ARC Centre of Excellence for Free Radical Chemistry and Biotechnology
- ARC Centre of Excellence in Ore Deposits
- ARC Centre of Excellence in Plant Energy Biology
- ARC Centre of Excellence in Structural and Functional Microbial Genomics
- ARC Centre of Excellence in Vision Science

A total of $122m over five years was awarded to these Centres from 2005.

In 2008, each Centre was reviewed and all 11 Centres received funding extensions totalling $82.25m over three and a half years from July 2010.

The 2003 cohort consisted of 15 Centres:

- ARC Centre of Excellence for Advanced Silicon Photovoltaics and Photonics
- ARC Centre of Excellence for Autonomous Systems
- ARC Centre of Excellence in Bioinformatics
- ARC Centre of Excellence for Biotechnology and Development
- ARC Centre of Excellence for Complex Dynamic Systems and Control
- ARC Centre for Complex Systems
- ARC Centre of Excellence for Functional Nanomaterials
- ARC Centre of Excellence for Integrative Legume Research
- ARC Centre of Excellence for Kangaroo Genomics
- ARC Centre of Excellence for Mathematical and Statistical Modelling of Complex Systems
- ARC Centre for Perceptive and Intelligent Machines in Complex Environments
- ARC Centre of Excellence for Quantum-Atom Optics
- ARC Centre of Excellence for Quantum Computer Technology
- ARC Centre for Solar Energy Systems
- ARC Centre of Excellence for Ultrahigh-bandwidth Devices for Optical Systems

A total of over $118.3 million over five years was awarded to these Centres from 2003. In 2006, each Centre was reviewed and 14 high-performing Centres received funding extensions totalling $71.4 million through to the end of 2010. One Centre received a funding extension for 2008 only.

The *ARC Centres of Excellence* scheme is administered under the Australian Government's National Competitive Grants Program (NCGP). Through the NCGP, the ARC supports the highest-quality fundamental and applied research and research training through national competition across all disciplines, with the exception of clinical medicine and dentistry.

More information on the ARC, including the *ARC Centres of Excellence* scheme, is available on the ARC website: www.arc.gov.au ■

# AUSTRALIA innovates

Over the past 30 years Australia has produced innovations that have had significant influence around the world. Here are just some of many possible examples.

## Relenza anti-flu medication

Flu virus has a part of its molecule that doesn't change through different generations. That was the key element for researchers trying to develop a treatment for flu, a common viral disease. CSIRO Division of Protein Chemistry was responsible for the achievement of the anti-flu drug Relenza. The use of the medication, after many tests, was finally approved for human use. Biota Holdings gave funds to its development, and the product was later manufactured by Glaxo Australia.

## Buffalo fly trap

In cattle farms, a common issue is the huge amount of flies that can cause damage to the animals. The flies can seem harmless, but their bite can lower the production of milk and cause injuries. An alternative to pesticides is the Buffalo fly trap, developed in 1992 by CSIRO. The fly trap is a tent that makes a tunnel with lined brushes. When the cattle cross the tent, the flies are brushed off and get trapped after flying towards the light of a plastic dome. The invention was manufactured by Country Industries Australia Pty Ltd.

## SmartModem

In 1982, Chris Howells developed an interface capable of linking different computers and establishing communication between them. Howells later became the creator and owner of NetComm, a successful company that improved the technology used in modems, creating more efficient equipment. The company then developed smaller and faster versions called SmartModems, which were first commercialized by NetComm in 1985. With even more improvements, 'superfast' SmartModems, which used surface-mount technology, were manufactured all over the world by 1992.

## Polymer banknotes

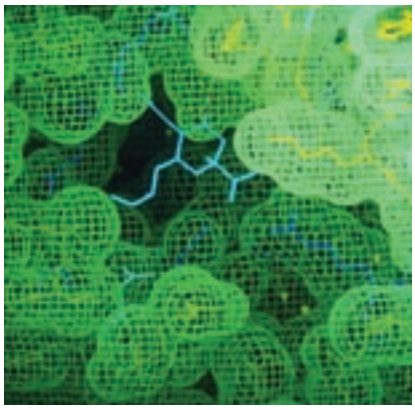
Polymer bank notes were created in Australia in 1988 and are now used in many countries. Polymer notes provide a better solution than utilising paper in terms of durability, security, and also hygiene – qualities not present in a paper banknote. The Reserve Bank of Australia and the CSIRO were responsible for the idea and realisation, developing a non-fibrous and non-porous material that enabled the use of more security features.

## Buried contact solar cell

A research team at the University of NSW led by Professor Martin Green designed a cheaper silicon solar cell with tiny, laser-etched grooves in which the wires (contacts) that carry the electric current are buried. This leaves a greater surface area to catch the sun's rays, making it more efficient. They are now commercially manufactured by Pacific Solar.

## Cochlear Implant

The Cochlear Implant has helped thousands of people to hear clearly again. When used with a microphone and speech processor,



The interaction of the anti-influenza drug Relenza™, buried in the active site pocket of influenza virus neuraminidase protein. *Photo by: CSIRO Molecular & Health Technologies.*

The CSIRO developed buffalo fly trap. *Photo by: CSIRO Entomology.*

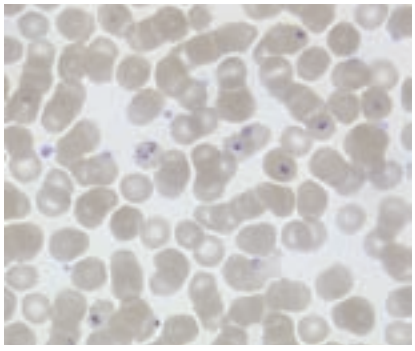
As of 2010, eight nations have fully converted to polymer banknotes, while another 15 nations have polymer banknotes in circulation. *Photo by: Martin Kingsley.*

Picture of Audio Processor with earmould for Electric Acoustic Stimulation (the use of a hearing aid and a Cochlear Implant together in the same ear) worn by user. *Photo by: Zipfer.*

The antennas of the Australia Telescope Compact Array, near Narrabri, NSW. *Photo by: Stewart Duff.*

Caduceus – The Beowulf cluster 'Caduceus' used for the identification of novel drugs 'in silico'. *Photo by: Mark Fergus.*

From the HIsmelt photo gallery (www.hismelt.com)



"Ring forms" of the Plasmodium falciparum (malaria) parasite, inside red blood cells. Microscope image using 100x oil-immersion lens. *Photo by: Michael Zahniser.*

the implant electrically stimulates the auditory nerve and results in the person being able to hear sound. After years of research and improvements, enough funds were raised to make and test a prototype of Professor Graeme Clark's invention. The commercialisation of the product began with the introduction of Nucleus 22 in 1983, after a partnership between University of Melbourne, Nucleus and the Federal Government. This collaboration led to the creation of Cochlear Pty Ltd, an Australian company specialising in the cochlear implant.

## Australia Telescope

The radio antennas that form the Australia Telescope receive huge amounts of information that are then processed by computers. In 1988, the Australia Telescope Compact Array, formed by six radio telescopes, was opened next to the town of Narrabri in New South Wales. Together with the radio telescopes in Coonabarabran and Parkes, they are collectively known as the Australia Telescope. The data obtained from many radio sources in space are used in radioastronomy research, making Australia an important collaborator. It is operated by the Australia Telescope National Facility, a part of CSIRO.

## Caduceus

Mr Kim Branson was a PhD student at CSIRO Health Sciences & Nutrition and the Walter & Eliza Hall Institute (University of Melbourne) when he designed and built the Caduceus supercomputer in 2000. Sixty-four computers linked together in a Beowulf cluster (high-performance parallel computing clusters of inexpensive personal computer hardware) form Caduceus. It screens millions of chemical compounds from a variety of sources to then identify, design or evaluate possible new drugs. Not only is the process incredibly fast, it also replaces labour-intensive lab testing.

## HIsmelt

HIsmelt is an air-based direct smelting technology developed by Rio Tinto to produce iron. Instead of gasifying coal and melting scrap to produce iron, the HIsmelt process smelts iron ore fines, non-coking coal and fluxes (pulverized lime), which are injected directly into the melt. This process eliminates the need for coke ovens and sinter plants, and it produces a high quality iron product. It reduces steelmaking energy requirements, making its production more environmentally friendly and with lower capital and operating costs. HIsmelt is the largest private research and development project in Australia, developed over 25 years at a cost of more than A$1 billion.

## Google Maps

The popular Google Maps mapping application was first developed in a Sydney-based company by brothers Lars and Jens Rasmussen, who founded Where 2 Technologies along with two friends, Stephen Ma and Noel Gordon. Their online mapping prototype impressed Larry Page, a Google co-founder, and in 2004 Google bought their company and technology. There are still engineers working on the application in Sydney, but the team is based in Google's Silicon Valley.

## The first genetically-modified strain of malaria

Scientists from the Walter and Eliza Hall Institute, led by Professor Alan Cowman, were the first to develop a genetically-modified strain of malaria. The Plasmodium falciparum, a protozoan parasite, is responsible for the highest mortality rates of malaria. By removing two of its key genes, the researchers successfully modified the parasite so that it can be used in the development of vaccines without the risk of malaria infection. The vaccine it is still being tested with trials in humans at the Walter Reed Army Institute of Research in Maryland, USA. ■

# Australian RESEARCH going global

Europe is Australia's major research partner, illustrated by the number of academic publications tracked adequately by Thomson publications data. Thomson is a key data source used to assess research performance, though it is limited in that the humanities and social sciences are not covered effectively. According to this dataset, the early 1990s marked a point of divergence between Australia's research collaboration with Europe and the United States (Figure 1). There is no consensus view that explains this trend, and FEAST is now investigating it.

Furthermore, FEAST's analysis reveals that most of the growth in Australia's research publications is associated with international collaboration rather than purely domestic efforts. The output of purely domestic papers is growing by around 200 per year, whereas papers with international authors are growing by roughly 600 per year (Figure 2). FEAST has been monitoring these trends and examining the best practice strategies to support these developments. Our general conclusion is that academic-to-academic collaboration between Australia and Europe is growing and is yielding useful results.

**Australian Collaborations with European Union, Europe and USA**

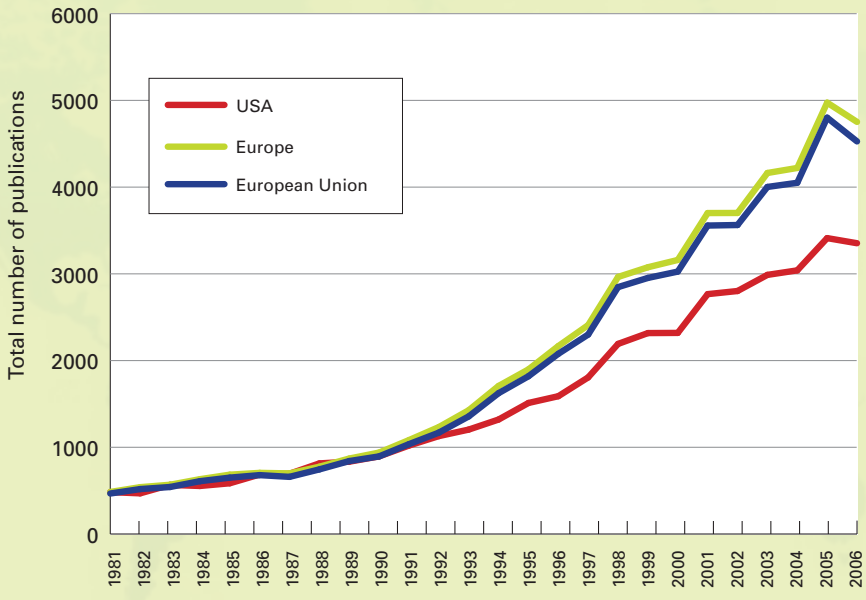
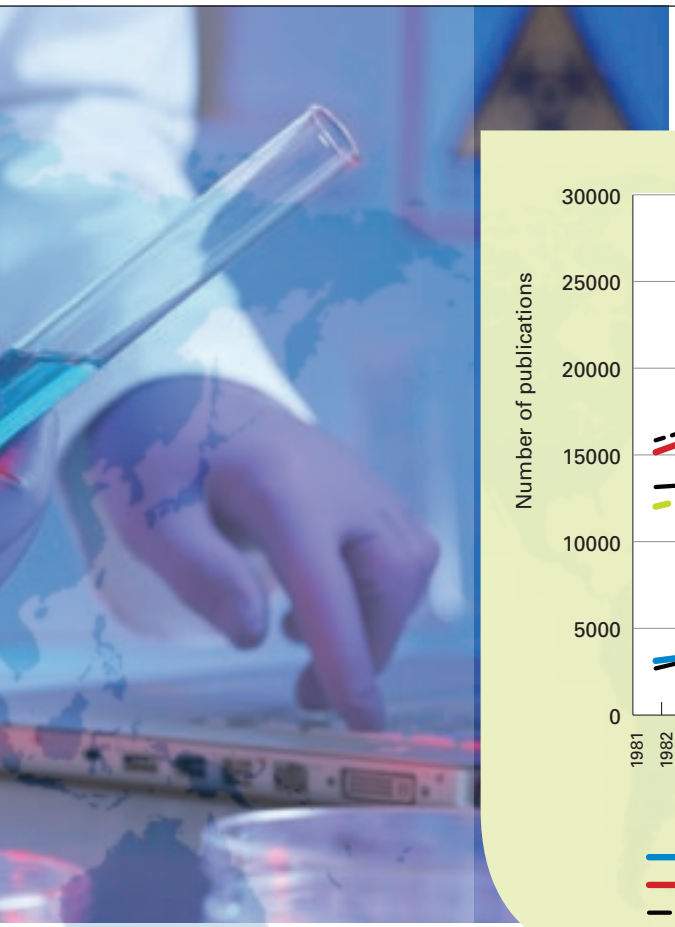



Figure 1: Australian Research Collaborations with European Union, Europe and USA as reflected in Thomson ISI tracked publications. *Source: Thomson data analysed by the ANU's Research Evaluation and Policy Project. Certain data included herein are derived from the Web of Science® prepared by THOMSON REUTERS®, Inc., (Thomson®), Philadelphia, Pennsylvania, USA: © Copyright THOMSON REUTERS® 2006. All rights reserved.*

In regard to strategy and policy, we recommend that international engagement should be treated as part of the 'core business' of doing research – not as an optional extra requiring targeted funding. From our perspective, the rules and regulations surrounding research funding that restrict scope for international collaboration are a key impediment preventing researchers from building these relationships. The reason is simple. Restrictions on the use of funding for travel and other costs of international collaboration limit the scope for conducting internationally engaged research. A more permissive approach to research funding would allow international collaborative relationships to be configured 'bottom up' in line with researchers' collective aims.

The Australian Research Council recently adopted a far more internationally engaged approach, involving a move toward truly global competition for funding for research to be performed in Australia. This was extremely welcome and commendable in its clarity of purpose,



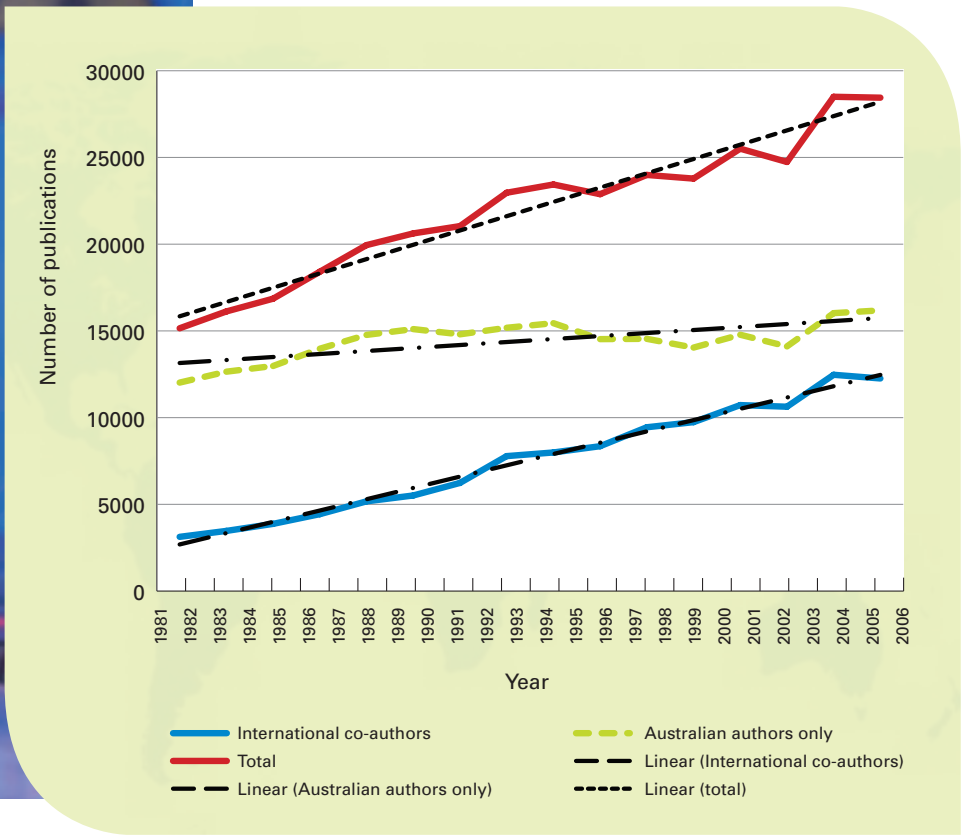



Figure 2: Number of publications by Australian researchers as tracked by Thomson ISI. Graph reflects the total number of papers (Total) or where either only Australian researchers were involved (domestic) or these were co-authors as part of an international collaboration (international). *Source: Thomson data analysed by the ANU's Research Evaluation and Policy Project. Certain data included herein are derived from the Web of Science® prepared by THOMSON REUTERS®, Inc., (Thomson®), Philadelphia, Pennsylvania, USA: © Copyright THOMSON REUTERS® 2006. All rights reserved.*

> the overall result of these international trends will be that research will become more 'borderless' and better able to exploit synergies and avoid wasteful duplication

since it now aligns Australia with international trends in research policy – for example the new European Research Council (ERC) adopts a similar approach.

The overall result of these international trends will be that research will become more 'borderless' and better able to exploit synergies and avoid wasteful duplication. We are moving toward a global knowledge commons in which the nationality and geographical location of researchers will matter much less than the webs of global relationships in which these researchers are embedded.

These webs of often complex relationships will increasingly constitute the critical intangible 'asset', from which public policy will seek to obtain a social, environmental and economic pay-off. It is not hard to see that understanding and tracing the outcomes from spending on research and innovation is set to become far less about the direct benefits arising for a nation and region/city. By contrast, it will be far more about the ways in which each nation, region and city performs research as part of a wider network that contributes to global advances – advances that are then drawn upon in a more 'customised' manner to address specific national, regional and indeed city-based challenges and opportunities.

The generation of useful research outcomes is the product of a complex global system of research and innovation. This has profound implications for how we go about both appraising potential research projects and evaluating the progress and outcomes that past projects have generated. Policy-makers must stop searching for the holy grail of easily traced 'smoking gun' audit trails that link research to useful outcomes via simple domestic causal chains. They must learn to accept that research generates useful outcomes by a process that often cannot be traced in a simple manner, precisely because a complex, but far more powerful, system of cause and affect is at work on a global scale.

*Dr Mark Matthews*

This article first appeared in the Australian R&D Review

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# Inspiring Australia, engaging the world


1.


2.


3.

4.

IMAGES:
1. Keeping on trucking; the Shell Questacon Science Circus has been enjoyed by more than 2 million people in their own communities across Australia.
2. Australian and Japanese science communicators learning from each other.
3. The Questacon-produced *Our Water* travelling exhibition attracts the attention of Minister for Water, Energy Efficiency and Climate Change, Senator Penny Wong.
4. Australia's latest Nobel Prize winner, Elizabeth Blackburn, former Prime Minister Kevin Rudd and Minister for Innovation Kim Carr help the audience understand the science of telomeres.

Questacon is Australia's multi-award winning National Science and Technology Centre. A visit to Questacon is an energetic hands-on, brains-on experience. Some 200 interactive exhibits are supplemented by engaging science shows from Questacon's in-house theatre troupe, the *Excited Particles*. www.questacon.edu.au

From its base in Canberra, Questacon delivers programs and activities across Australia. The Shell Questacon Science Circus, which celebrates its 25th anniversary in 2010, is one of the world's best known science centre outreach programs. Enthusiastic science graduates studying for a post-graduate diploma in science communication at the Australian National University deliver science shows and a mobile science centre experience to regional and remote communities. http://sciencecircus.questacon.edu.au/

Questacon also delivers mathematics, early childhood and indigenous outreach programs. The Smart Moves program focuses on innovation and an annual Smart Moves Invention Convention brings together some 30 young Australians for a week-long program of activities designed to encourage entrepreneurship. http://smartmoves.questacon.edu.au/

As a Division within the Australian Government's Department of Innovation, Industry, Science and Research, Questacon administers important activities such as National Science Week and the Prime Minister's Prizes for Science, as well as a grant program for science communication activities. In 2009 Questacon took a lead role in producing the report, *Inspiring Australia: a national strategy for engagement with the sciences.* http://www.questacon.edu.au/national/inspiring.html

This landmark report recognises that although Australia has great strengths in communicating science, there is a need for leadership and more coherent activity across the country. In order to fully realise the social, economic and environmental benefits of investment in science and research it is critical that the broader public become informed and engaged. As a well-respected national institution, Questacon is well-placed to lead the *Inspiring Australia* initiative over the next decade and to share the knowledge gained throughout the world science centre community.

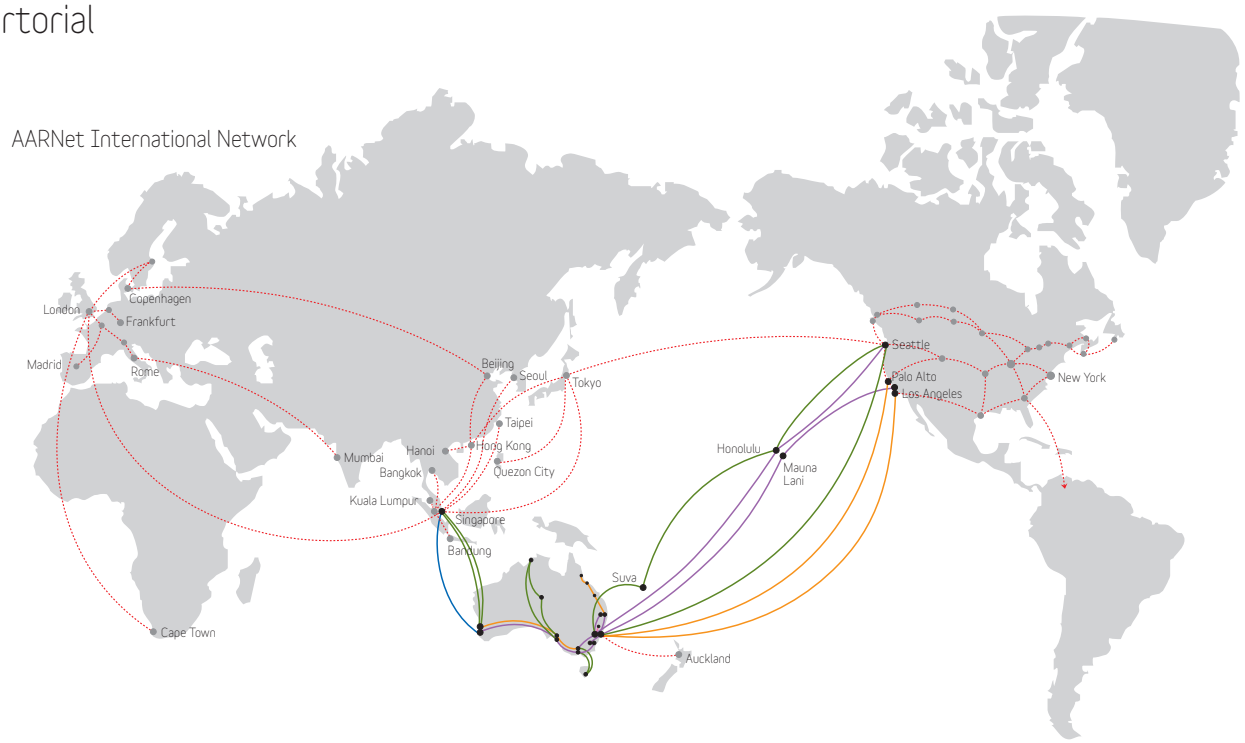
Questacon is one of the world's most influential science centres, with staff playing key roles in the global science centre network. Questacon has a strong tradition of supporting the emerging science centre sector in Asia and Africa by sharing knowledge, providing programs or touring exhibitions. A special relationship with Japan dates back to 1988, when the Japanese Government and business sector assisted with the cost of the Questacon building.

Questacon was the first science centre in the Southern Hemisphere and one of the first science centres to provide interactive content on the Web. Today it pioneers interactive international engagement through high-bandwidth connectivity.

In partnership with others, Questacon is playing an important role in the Australia-New Zealand bid to the host the 5000km long Square Kilometre Array radio telescope by supporting public awareness and educational activities. www.ska.edu.au

The SKA project exemplifies the inclusive global partnership approach that is now required, not only for scientific research, but also for science communication.

*Professor Graham Durant*
*Director, Questacon*




# AARNet: Advancing Research and Collaboration in Asia Pacific and Europe

In The Tyranny of Distance, historian Geoffrey Blainey outlined how Australia's geographical isolation has contributed to the country's economic and social development. With advancements in telecommunications technologies, this distance is no longer an impediment. Instead, a high speed network operated by Australia's Academic and Research Network (AARNet) has propelled Australia to the forefront of the world's intellectual community.

AARNet is a not-for-profit organisation that is owned by shareholders comprising of 38 universities in Australia and the Commonwealth Scientific and Industrial Research Organisation (CSIRO). Over the last 20 years, AARNet has developed its reputation as being one of the world's most advanced National Research and Education Networks (NRENs) serving more than one million end users in universities and research institutions with connection speeds of up to 10Gbps.

As a member of the Trans-Eurasian Information Network (TEIN3), AARNet links Australian researchers and scientists with their counterparts in Asia Pacific and Europe through high-speed direct links to facilitate collaboration and research.

Chris Hancock, CEO of AARNet said, "Having a world class high speed network provides Australian and European researchers and scientists the unprecedented opportunity to collaborate on a wide variety of programs that are of great significance to the international community. AARNet is a founding member of the EXPReS consortium, a project to create a distributed astronomical instrument of continental and intercontinental dimensions using electronic Very Long Baseline Interferometry. Today, we continue to support Australia's bid for the Square Kilometer Array through our partnership with CSIRO."

The Square Kilometer Array (SKA) is an example of how AARNet has allowed research and collaboration to take place on an international scale by transmitting and correlating astronomy data captured in Australia and around the world. AARNet has also been instrumental in advancing telemedicine in Asia through its links with Kyushu University Hospital in Japan. Medical practitioners in Japan, Korea, China and Australia can participate in high definition video conferences to be trained on endoscopic and gastrointenstinal surgeries. By leveraging AARNet's connectivity, medical professionals will be able to improve patient care and allow patients to be remotely treated.

Shuji Shimizu, MD and Chairman of the Asia-Pacific Advanced Network Medical Working Group said, "These live demonstrations have opened a new era for the medical community throughout Asia Pacific. The support from AARNet enables medical professionals to share their skills with a wide audience, ultimately providing patients with prompt and better healthcare."

Looking beyond collaborative research programs, AARNet has been the springboard in facilitating the roll out of the eduroam federation (www.eduroam.org) in Asia Pacific since 2005. It recently connected the Papua New Guinea Academic and Research Network (PNGARNet) to the eduroam federation. Researchers visiting Papua New Guinea can now access a secure wireless internet network to transmit information and communicate with their international counterparts.

Hancock added, "Our collaboration with other NRENs in Asia Pacific has further cemented Australia's position as a key research and collaboration hub in the Southern Hemisphere. AARNet encourages the development of research partnerships between the European and Asia Pacific regions. We continue our commitment to support programs that will advance Australia and the region's reputation in the world's research community."

**In 2009, AARNet commemorated the 20th anniversary of the Internet in Australia with the release of a book AARNet – 20 years of the Internet in Australia to document the history of how the Internet network was established in Australia through AARNet. The book can be downloaded from www.aarnet.edu.au**

aarnet
Australia's Academic and Research Network

# Finding answers through high-speed networks

In trying to find answers to the mysteries of the universe, researchers and scientists have relied on the Internet to communicate, collaborate and learn from each other. A significant number of partnerships exist between Australian and European researchers on global projects that rely on AARNet, Australia's Academic and Research Network.

AARNet provides high-capacity Internet services for Australia's tertiary education, research sector communities and their research partners. It is built on a highly resilient backbone that stretches across Australia, onwards to the United States and Singapore and interconnects with the European research networks. The AARNet network connects Australian universities and research institutions on speeds of up to 10Gbps and serves more than one million end users. It continues to play an integral role in collaborating with other Research and Education Networks around the world in major research programs, such as the Square Kilometre Array and the Large Hadron Collider (LHC).

Chris Hancock, CEO of AARNet said, "AARNet has developed one of the most advanced national research and education networks anywhere in the world. This has placed Australia at the forefront of the world's research and scientific programs by allowing Australian researchers to collaborate with their counterparts in Asia, Europe and the United States."

Researchers at the Universities of Melbourne and Sydney have been working closely with AARNet to prepare and build the Australian nodes of a global network of physics analysis centres for the Worldwide Large Hadron Collider Computing Grid (WLCG). Connecting to the WLCG through AARNet enables teams of research staff and students in Melbourne and Sydney to analyse their data, conduct detector calibration, alignment and data monitoring from their home laboratories.

Professor Geoffrey Taylor of the School of Physics at The University of Melbourne and leader of the Australian effort at CERN's LHC said, "The University of Melbourne is actively involved in the Large Hadron Collider program and the 10Gbps access point that connects us to AARNet and the Southern Cross Trans-Pacific Optical Research Test bed to facilitate our collaboration with scientists and researchers in the United States, Asia and Europe by allowing very large amounts of data to be transferred for analysis quickly."

Julia Gillard launching the OziPortal at the University of Melbourne in January 2008.
Photo by: Les O'Rourke and University of Melbourne

**10 Gbps**

**the speed at which Australian universities and institutions can connect via AARNet.**

Two antennas of the Australia Telescope Compact Array, near Narrabri, NSW.

Australia has long supported global astronomy research with AARNet's high-speed network. Researchers and scientists have been able to create a distributed, large-scale astronomical instrument of continental and inter-continental dimensions known as an electronic Very Long Baseline Interferometry (e-VLBI), where fibre optic networks connect radio telescopes to a central data processor to correlate the data from the telescopes in real time.

This program allows scientists in Asia, Australia and Europe to collaborate on e-VLBI projects by connecting Australian telescopes in the cities of Parkes, Narrabri and Coonabarabran to telescopes in China, Japan and Europe to gather and correlate data for e-VLBI research co-ordinated by the Joint Institute for VLBI in the Netherlands.

Tasso Tzioumis, Research Scientist at the CSIRO said, "AARNet has made an invaluable contribution in allowing Australian researchers to collaborate with the international research community. By making their lightpaths available for the transmission of data, we have been able to produce significant research findings which would be almost impossible to achieve without a high-speed network of this nature."

For further information on AARNet, visit www.aarnet.edu.au ■

# Melbourne, Australia
# Innovation capital of the Asia-Pacific

Melbourne, Australia is delivering new products to the global market that address early-detection disease, improved patient management and novel treatments.

We continue to advance with forward-looking research institutes and companies that are building innovative solutions for a healthy, sustainable and productive future for the world.

To learn more go to www.vicbioportal.org

MELBOURNE
VICTORIA AUSTRALIA

# Melbourne
## innovation capital of the Asia-Pacific



Melbourne, the capital city of Victoria and the world's third most liveable city[1], enjoys one of the strongest economies in the world. The Victorian Government leads Australia in setting out strategic directions and an environment to develop an innovative 21st century economy.

Victorian innovation initiatives involving A$4 billion over the past 10 years have created a dynamic, internationally competitive and globally connected economy.

Melbourne's future includes:

- the largest Boeing Corporation design, research and technology hub outside of the USA
- the Australian Synchrotron
- IBM's largest supercomputer dedicated to life sciences
- Australia's Bionic Eye project
- CSL, one of the world's top 10 biopharmaceutical companies

### Aerospace and Aviation

Victoria is a global centre of excellence in the aviation and aerospace industry, with expertise in research and development through to final manufacture and production. Victoria has the region's largest concentration of aerospace education and training facilities in the Asia-Pacific. Melbourne will soon be the largest Boeing Corporation design, research and technology hub outside of the US, and it will become a designated centre of excellence for composites. Victoria's aviation and aerospace industry capabilities include airframe design, manufacture and testing, avionics, precision engineering and ground support equipment.

### Victoria's excellence in ICT

Victoria is Australia's leading centre for information and communication technology (ICT), employing around 87,000 people – approximately one-quarter of Australia's ICT industry – and ICT companies operating in Victoria have gross annual revenues of $27.4 billion.

Melbourne is home to NICTA (National ICT Australia), Australia's Information and Communications Technology Centre of Excellence. With over 700 people, NICTA is the largest organisation in Australia dedicated to ICT research, commercialisation and research training. By focusing on use-inspired basic research to address the technology challenges facing industry, community and the national interest, NICTA aims to be one of the world's top 10 ICT research centres by 2020. NICTA's key business areas include

the life sciences, intelligent transport systems, safety and security, environmental management and mobile systems and services.

The world's most powerful supercomputer dedicated to life sciences research is currently being built in Melbourne. A collaboration between IBM, the Victorian Government and the University of Melbourne, the Victorian Life Sciences Computation Initiative (VLSCI) will establish a supercomputer of over 800 Teraflops.

The VLSCI will provide Victoria's researchers with the necessary tools to solve some of the biggest challenges facing our health system and impacting our quality of life. The supercomputer initiative will enable researchers to process genes to identify the risk of cancer and

treatment, model brain functions to treat brain disorders and disease, and model and predict threats of infectious disease.

### Australia's Bionic Eye Project

Two Melbourne institutes have been selected by the Australian Government to tackle the development of a bionic eye to treat the most common forms of adult blindness. The two consortia, Bionic Vision Australia and Monash University, are collaborations between material scientists, electrical and electronic engineers, ICT, biomedical researchers, behavioural scientists, clinical neurosurgeons and ophthalmologists. Bionic Vision Australia aims to develop a high resolution device to be implanted in the rear of the eye, while the Monash University-led consortium aims to develop an implant to stimulate the visual cortex within the brain bypassing the eye and optic nerve.

### Life Sciences

Melbourne is Australia's leading biotechnology location with strengths in cancer, neuroscience, stem cells, infectious disease and immunity, thanks to a combination of skilled and committed researchers and companies collaborating closely with a supportive and innovative State Government.

The market value of Victoria's listed biotech companies tripled between 2001-2002 and 2009. Some 22,000 ➤

# Research at the University of Ballarat

## Where the individual counts!

The University of Ballarat is offering a number of Post Doctoral Research Fellowships and Higher Degree by Research scholarships in celebration of 140 years of higher learning in Ballarat.

The University is keen for you to contribute to the University's research and innovation profile through collaborative and significant knowledge partnerships and for you to be a part of the supportive research environment that has emerged at UB; *where the individual counts!*

UB has made and will continue to make significant investment in the priority Research Themes and you are invited to be a part of the next stage of research endeavour at UB. You will work with highly respected researchers of the University within, or across, our Research Themes: *Informatics & Applied Optimization; Addressing Disadvantage & Inequality in Education and Health; Regional Futures, and Injury Prevention & Safety Promotion.*

The Post-Doctoral positions are offered on an initial 2 year period (with a performance review at 18 months), with the possibility of a 3 year extension following successful progress.

The University of Ballarat is the only regionally headquartered, multi-sector university in Australia and has approximately 25,000 students. *Dare to be Different* is the motto for the University and a strong belief in this motto has always been in evidence. The University has gained a national reputation for its commitment to high quality learning, teaching and training, for its applied research and for its engagement with industry, business and its regional communities and for its innovative Technology Park, the largest in regional Australia, which facilitates and promotes new technology in products and services through scientific and industrial research.

The University's Mt Helen campus is set on 110 hectares of natural bushland with resident kangaroos and koalas and an abundance of natural wildlife and is adjacent to the Technology Park; ideally situated to take advantage of the applied, academic and research knowledge available at its doorstep. The University also has campuses located in the Ballarat CBD providing modern facilities within attractive and historic buildings.

Ballarat, the Garden City, is home to close to 90,000 residents and provides access to significant historical, cultural and sporting activities and events. Ballarat has some of the most affordable housing in the state with a relaxed lifestyle on offer including fabulous wining and dining experiences. It is located only one hour via train or car from Melbourne and less than an hour to beautiful beaches. There is a large choice of excellent secondary schools, both public and private, to choose from if required.

At least one of the Post Doctoral positions will be located at the University's modern facilities on the Horsham campus. The campus services the Wimmera region of Western Victoria. Horsham has approximately 14,000 residents with a dynamic arts community, fine food and wine production, and is located close to natural attractions such as the Grampians.

We welcome your enquiries...
We look forward to welcoming you to UB and to experience for yourself the *Dare to be Different* spirit of the University of Ballarat where our students learn to succeed, and *where the individual counts!*

Enquires should be directed to the Pro Vice-Chancellor (Research), Professor Frank Stagnitti, at PVC.Research@ballarat.edu.au

Visit www.ballarat.edu.au/ard/ubresearch/ today.

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University of Ballarat
Learn to succeed

people are employed in the lifesciences field, and exports have grown to $1 billion of biotechnology and pharmaceutical products each year.

Victoria remains at the leading edge of influenza research and vaccine development, with companies such as CSL developing the first H1N1 (swine flu) influenza vaccine, Biota/GlaxoSmithKline producing RelenzaTM for the treatment of flu and BioDiem developing leading flu vaccination technology. Melbourne is home to the World Health Organization Collaborating Centre for Reference and Research on Influenza, one of only five WHO collaborating centres for influenza.

Melbourne's frontline research institutes have made numerous medical breakthroughs. Examples include the identification of a critical step in the malaria parasite lifecycle (Burnet Institute, Walter and Eliza Hall Institute of Medical Research [WEHI] and Deakin University); identification of a new stem cell behind the most dangerous forms of breast cancer (WEHI); and the discovery of genes linked to a susceptibility to MS that may help to identify the causes of MS and other auto-immune diseases (Florey Neuroscience Institutes).

The Australian Regenerative Medicine Institute (ARMI) is one of the world's largest regenerative medicine and stem cell research institutes and is also the headquarters for the Australia Partner Laboratory of the renowned European Molecular Biology Laboratory (EMBL). ARMI leads a group of laboratories throughout Australia with research teams employed according to the philosophy and principles of the EMBL. In this model, guaranteed basic research resources are provided to outstanding young researchers who are competitively selected from an international talent pool.

The extensive Victorian BioPortal database provides links to every Victorian-based company presently developing and applying bioscience discoveries to solve today's most urgent challenges in health, agriculture, industry and environmental sustainability. The Victorian BioPortal is also a key gateway to the Victorian Platform Technologies Network (VPTN), which helps connect researchers and industry with other organisations within the biotechnology sector.

*To access regular updates on current research and investment, and to learn more about the depth and excellence of Victoria's biotechnology sector visit:* www.vicbioportal.org

## Competitive Research Infrastructure

Opened in 2007, the Australian Synchrotron is already transforming Australia's scientific and industrial research capacity and enhancing Melbourne's status as a world-leading location for frontline life science.

Providing immensely bright photon beams (from infrared to hard X-rays) and using some of the world's newest and most advanced beamlines, the Synchroton is speeding up drug target identification, enabling groundbreaking research and advancing work on new medical therapies.

In May 2009, the Victorian Government and the Australian Government announced funding for a new $1 billion cancer centre in Melbourne – the Parkville Comprehensive Cancer Centre. The purpose-built centre will bring together six world-class cancer research organisations, including the Ludwig Institute for Cancer Research, the Peter MacCallum Cancer Centre and the University of Melbourne. It will focus on innovation and collaboration in cancer research and treatment, bringing together the nation's best researchers, clinicians and educators.

AgriBio, Victoria's new $230 million biosciences research centre, is set to put Victoria at the forefront of global agricultural research. AgriBio will specialise in biosciences research and development, plant and animal genomics, plant pathology, animal health and agricultural sustainability. By offering state-of-the-art facilities and well-established Victorian expertise in biosciences, the centre will attract leading scientists from around the world and foster collaboration across scientific disciplines to provide advanced research and development required to meet climate change and environmental challenges.

The Victorian Government works with a range of science and technology sectors to successfully pursue international alliances. In 2009 the Victorian Government established its largest-ever international agricultural biotechnology research partnership – an alliance with Dow AgroSciences – to develop new plant varieties that will meet the growing global demand for food, livestock feed and energy. Over US$22.7m in health projects have been joint-funded between Victorian researchers and the California Institute of Regenerative Medicine (CIRM) through the Victoria-California Stem Cell Alliance. These projects are CIRM's first ever international partnerships.

Victoria has made innovation a priority, providing the leadership and infrastructure to build up its knowledge and skills-driven sectors, while advancing with forward-looking research institutes and companies that are developing solutions for a healthy, sustainable and productive future for Australia, and the world.

*Dr Amanda Caples, Director, Science and Technology Programs and Director, Biotechnology for the Victorian Department of Innovation, Industry and Regional Development*

[1] Source: Economist Intelligence Unit, 2010

# **New South Wales** for international research partnerships

## The NSW Government supports and builds research capabilities in the State through funding programs, awards and by facilitating structured engagements between business, university and government.

New South Wales and its capital city Sydney is a leading centre for research capabilities in smart technologies – from next generation communications, quantum computing, microelectronics and advanced robotics, through to solar energy, and biotechnology.

New South Wales is home to:

- 11 universities
- 11 Australian Cooperative Research Centres
- 7 Australian Research Council Centres of Excellence
- The Australian Nuclear Science and Technology Organisation's state-of-the-art OPAL nuclear research facility
- Major medical research hubs
- Thriving technology parks and innovation precincts

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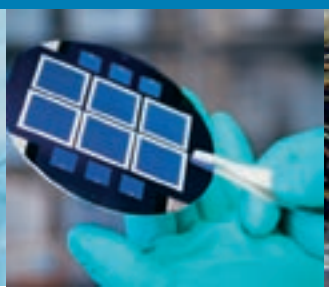



New South Wales Government
Australia

Contact the Office for Science and Medical Research on **+61 2 9338 6787**
or email **info@osmr.nsw.gov.au**
**www.sydneyaustralia.com**

SYDNEY

# New South Wales leading Australian research

New South Wales boasts outstanding research capacities across a variety of areas – from food safety and security, to environmental management, climate systems, communications, agriculture, health and more. NSW has the largest research sector in Australia – a country ranked first in the Asia Pacific Region for the quality of its research institutions, and tenth worldwide by the World Economic Forum survey.

Every year, $6.2 billion is spent on research, and that commitment is reflected in the research institutions, 11 universities, technology parks and innovation precincts and leading-edge, high-tech companies located in NSW. The Australian Nuclear Science and Technology Organisation's (ANSTO) state-of-the-art OPAL nuclear research facility is based in Sydney, together with 11 Cooperative Research Centres and seven Australian Research Council (ARC) Centres of Excellence. NSW also has vibrant medical research culture, with seven dedicated medical schools at universities, 14 of Australia's major teaching hospitals and eight medical research hubs.

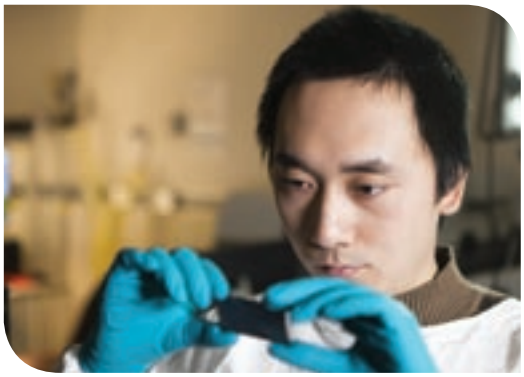
## Robotics and Autonomous Systems

*"In the past 15 years Australia has come to lead the world in the development and application of robotics in large-scale outdoor field applications. Robotics and autonomous systems will be one of the most important and transformational technologies in the future of this country."*

– Professor Hugh Durrant-Whyte
FRS Research Director, ARC Centre for Autonomous Systems, Sydney

Sydney is proud to be home to The Centre for Autonomous Systems (CAS), which brings together the Australian Centre for Field Robotics at The University of Sydney; the Artificial Intelligence and Mechatronics Group at The University of NSW; and the Mechatronics and Intelligent Systems group at the University of Technology, Sydney.

Both domestically and internationally, the CAS collaborates closely with industry and in established and developing application domains. These industry engagements have placed autonomous systems at the forefront of new technology developments in Australia and around the world. For example, the Rio Tinto Centre for Mine Automation, located at The University of Sydney node, has become a global centre of excellence for research in robotics for the mining industry. The BAE Systems Centre for Intelligent Mobile Systems, also at the University of Sydney, represents a significant long-term investment in autonomous systems research by one of the world's largest aerospace and defence companies.



Sumo robot wars.

The CAS has over 20 industry-supported projects currently putting robotics research to work in applications such as agriculture, cargo handling and infrastructure maintenance.

The CAS has also been developing the technology to deploy robotics in applications more closely associated with society and the environment, such as health and rehabilitation, entertainment and art, marine science and terrestrial ecosystem stewardship.

With a major role to play in teaching and training postgraduates, undergraduates and industry partners in robotics science and technology, the CAS has developed strong links with many national and international centres of expertise in autonomous systems.

## Solar Flagships

Under the Australian Government's Solar Flagships program commencing in late 2010, $1.5 billion in funding will be provided over six years for the construction and demonstration of up to four large-scale solar power plants in Australia in partnership with the States and Territories and the private sector. This will be accompanied by a $200m education funding pool shared among research institutes in project states.

New South Wales is well placed to lead Australia on solar energy projects. The NSW Government's Greenhouse Gas Reduction Scheme, introduced in January 2003, was one of the first mandatory emissions trading schemes in the world, and the state is the world's second largest carbon market in terms of both volume and value of carbon credits. NSW has significant natural advantages for large-scale solar ➤

**20%**

**the NSW Government renewable energy consumption target for 2020**

Marulan Heli trial.

The University of Sydney, host to Professor Simpson's research into a new way of modelling nutrition.

power – the largest electricity market in Australia and a range of locations close to the grid with good solar resources.

NSW also has world-class research and development capacity in both solar thermal and photovoltaic technologies, including:

- The Photovoltaic Centre of Excellence at the University of New South Wales. This leading centre for silicon photovoltaic research and commercialisation specialises in high efficiency and affordable wafer cells, thin film cells, third generation photovoltaic concepts and characterisation equipment;
- The CSIRO's National Solar Energy Centre in Newcastle, which is developing solar thermal technologies and is home to the largest high concentration solar array in the southern hemisphere.
- Australian Solar Institute at Newcastle, which coordinates major research efforts in photovoltaic and solar thermal.

Other NSW renewable energy initiatives include:

- a Government target to increase our renewable energy consumption from 6 per cent to 20 per cent by 2020;
- establishment of six Renewable Energy Precincts to drive wind energy investment, development and uptake in NSW; and
- a $40m Climate Change Fund Renewable Energy Development Program to support the demonstration and early commercialisation of new renewable energy technologies.

## Smart Grid Project

The city of Newcastle is the site for Australia's first commercial-scale smart grid as part of the Australian Federal Government's $100 million Smart Grid, Smart City initiative.

The demonstration project will be led by EnergyAustralia and its consortium partners – the NSW Government, Newcastle City Council, IBM Australia, AGL, GE Energy and Transgrid. It will lead Australia-wide advances in energy management by gathering robust information about the costs and benefits of smart grids to inform future decisions by government, electricity providers, technology suppliers and consumers across Australia. It will bring some of the most advanced electricity and energy systems in the world to NSW.

The project will encompass:

- The conversion of thousands of households in NSW into 'smart homes' to trial in-house displays, websites and remote control appliances to track electricity and water usage.
- Renewable energy and battery storage trials to generate power locally in Sydney CBD.
- A trial fleet of electric vehicles and charging stations in public areas.
- The conversion of households into virtual green power stations that could power local streets during blackouts through battery storage trials.
- The roll-out of smart sensors across the EnergyAustralia network allowing earlier fault detection, repair and even self-repair of some faults.

The *Smart Grid, Smart City* project will also demonstrate the capacity of the network to use renewable energies more effectively than the existing electricity grid, and explore synergies between smart grid technologies and the National Broadband Network.

## World class talent

NSW research strengths also attract high quality research students and world leading researchers, such as the NSW Scientist of the Year 2009, Professor Stephen Simpson.

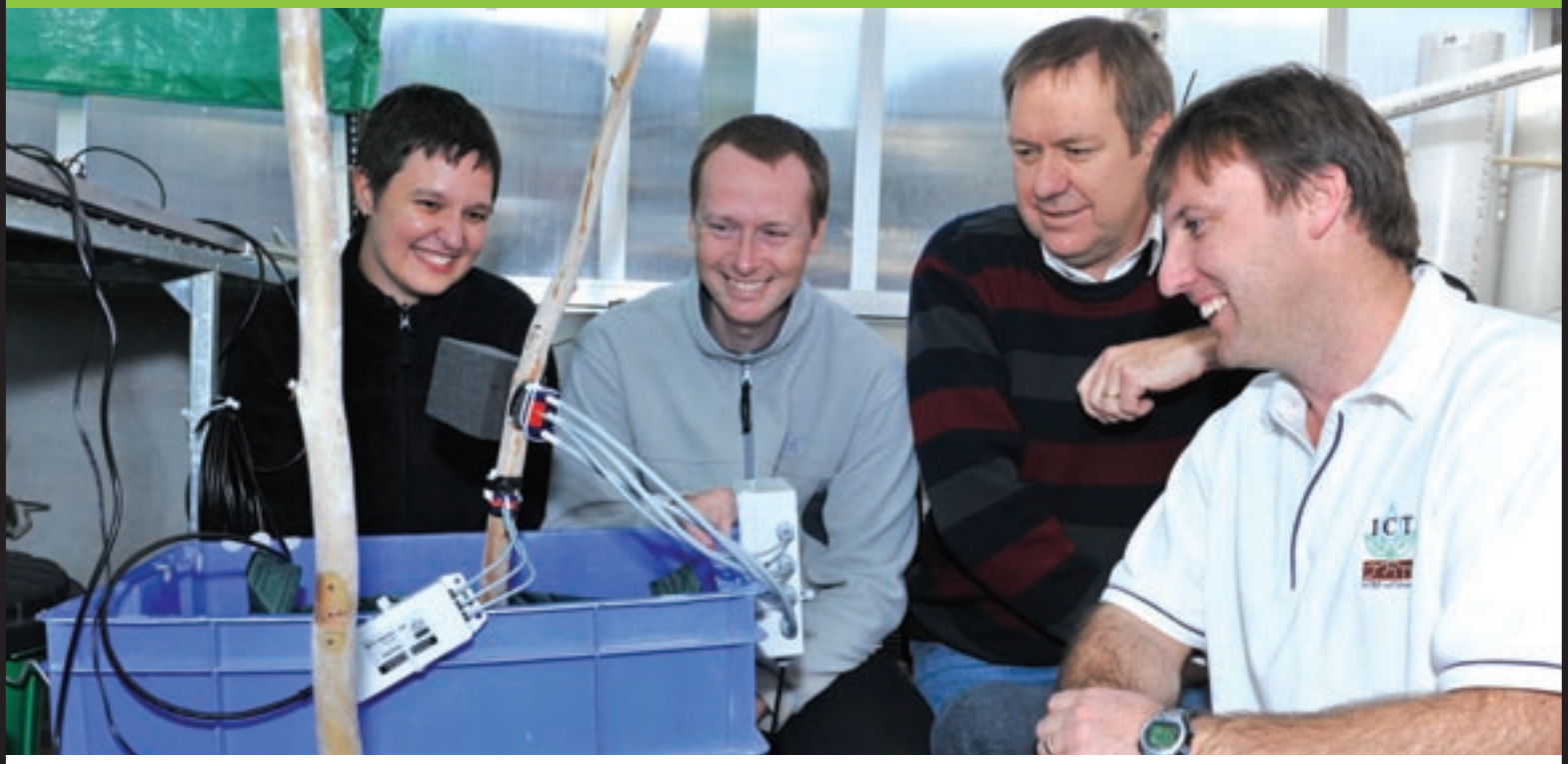
Professor Simpson is a Federation Fellow in the School of Biological Sciences at the University of Sydney. His research on locusts and what causes them to swarm, has led to some amazing findings. By devising and applying a new way of modelling nutrition, Professor Simpson has made novel advances in major problems in ecology, evolution, agriculture and human health.

Professor Simpson's research is helping to tackle challenges in a range of different areas, including:

- fundamental insights into the dietary causes of the human obesity epidemic and the ageing process;
- links between individual physiology, including chemical events within the brain, and mass migration in locusts, which has helped predict and manage locust outbreaks;
- new approaches to optimising animal feeds in the aquaculture industry, to help minimise environmental impacts and maximise fish welfare;
- the conservation of endangered species such as kakapo parrots and wild primates.

With all this going on, NSW is recognised around the world for its knowledge, creation and innovative capabilities. ■

# World-class research happens in surprising places




Above: (from left) Professor Kathy Steppe (Ghent University) and Dr Dirk De Pauw (Phyto-IT, Belgium) working with Dr Nigel Warwick (UNE) and Alec Downey (ICT International, Armidale, Australia) testing the measurement of stress in trees.

**As the first Australian university established outside a capital city, and with a history extending back to the 1930s, UNE has a well-earned reputation as one of Australia's great teaching and research universities.**

While UNE has a long history and strong tradition, our outlook is progressive and fresh. Our focus is on the future, with dynamic research taking place with colleagues around the world.

UNE staff are part of a community - focused on the relentless pursuit of excellence and innovation. We know our most exciting chapters are still to be written: we invite you to help us write them.

UNE researchers are currently collaborating with European partners on a wide variety of research projects. Take a look at just a few:

- **Models of Social Welfare**
  (the "NordWel" research network, coordinated at the University of Helsinki)
- **Natural Resource Governance**
  (the Icelandic Soil Conservation Service and the European Commission)
- **Measuring Environmental Stress in Trees**
  (Ghent University)
- **Homotopy Theory**
  (the Max Planck Institute for Mathematics, Bonn)
- **Laterality in Animals**
  (the University of Sussex, UK; the University of Trento, Italy)
- **Science Education – the IRIS Project**
  (the European Union)
- **Plant Systematics**
  (Royal Botanic Gardens, Kew; Catholic University of Leuven; University of Munich; Imperial College London; University of Leiden)

**For more information on research facilities and collaborations at UNE, contact UNE Research Services**

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# Discover the difference

# Western Australia








## Western Australia is at the forefront of leading edge science and innovation.

### Square Kilometre Array

Western Australia's expertise and capabilities in radio astronomy are supporting Australia and New Zealand's bid to host the $2.5 billion Square Kilometre Array, one of the world's largest science projects.

### World leading research

Our internationally recognised research institutes are at the forefront of marine science, desalination, supercomputing, subsea oil and gas technologies, geothermal energy, children's health, e-medicine, radio astronomy, clinical trials and data linkage.

### Australian Marine Complex

The unique and internationally recognised Australian Marine Complex is home to 120 businesses providing training, engineering, research and manufacturing support to the resources, marine, shipbuilding and defence industries.

SIB_Jul_2010/DP0062/2009/01

**To discover what opportunities exist in Western Australia for your business call +61 8 9282 0777 or visit:**

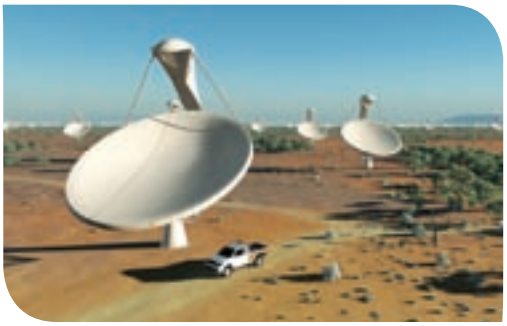
**www.commerce.wa.gov.au/scienceinnovation**

# Discover the difference in Western Australia


Measures are taken to guard radio quiet zones in WA's sparsely populated mid-west.

Western Australia (WA) is at the core of leading edge science and innovation.

The Western Australian Government, through the Department of Commerce, is building the State's capabilities in science, innovation and technology and facilitating the growth of WA's innovation-based industries.



WA is a biodiversity hotspot with a sophisticated workforce, world-renowned scientists and an innovative spirit.

The State has developed internationally recognised capabilities in mining and mining services, medical research, subsea oil and gas technologies, supercomputing, shipbuilding, geothermal energy, e-medicine, radio astronomy and data linkage.

Complementing this is our cluster of Cooperative Research Centres and Centres of Excellence for industry-specific research and development. They build the State's knowledge base and enhance the competitiveness and sustainability of our economy.

WA's local biotechnology, pharmaceutical and clinical research sectors will also benefit from the establishment of the first dedicated clinical trials facility at the QEII Medical Centre in Perth. The facility will also help the State to attract high quality national and international scientists to undertake ground breaking research that will benefit the community.

The State Government is supporting innovation and entrepreneurship within WA through the Innovation Centre WA.

The Centre provides infrastructure and services to support emerging innovative enterprises. It helps to bridge the gap between the development and commercialisation of ideas into viable and sustainable enterprises and products.

An Emerging Technologies Incubator has been established at the Centre. The Incubator provides a physical location for early-stage innovative technology firms to grow at an accelerated rate through the provision of training, mentoring and office support services.

Western Australia is on the cusp of participating in one of the greatest scientific endeavours in the world, the Square Kilometre Array (SKA).

The SKA will be the largest ground-based international astronomical facility of the 21st century. This project will allow scientists to peer back in time to answer the imponderable questions about the formation and evolution of the Universe.

Australia and New Zealand have been shortlisted alongside Southern Africa as a potential destination to host this impressive project. The site in WA's mid-west offers exceptional radio quietness, one of the single most important requirements in radio astronomy.

This project presents a significant opportunity to diversify Western Australia's economy and enable the State to become a central hub for international radio astronomy research.

To ensure this is realised, the State Government has invested A$20m in the establishment of the International Centre for Radio Astronomy Research (ICRAR).

ICRAR, a joint venture between Curtin University of Technology and the University of Western Australia, will be instrumental in the design and development of technology for the SKA (see more about ICRAR pp.72-73).

The centre recently signed a memorandum of understanding with IBM to research and develop IT systems for the transfer, management, processing and storage of the vast amount of radio astronomical data likely to be produced by the SKA – an estimated exabyte of data per day or about 1000 million 1GB memory sticks.

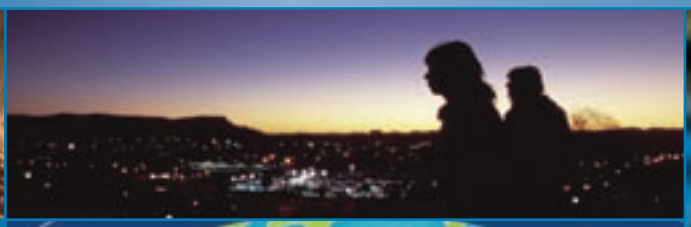
WA's existing capabilities in high performance computing were also the catalyst for the Federal Government's decision to locate the new Pawsey High Performance Computing Centre for SKA Science in Western Australia. The centre will house a supercomputer capable of performing computational science almost 55,000 times faster than a typical PC.

Delivered by iVEC, the hub of advanced computing in Western Australia, the Pawsey Centre will help to build a high performance computing hub in the State, which will support the SKA, as well as high-end research in many disciplines, including nanotechnology, biotechnology, geoinformatics, engineering and atomic physics.

To learn more about opportunities in WA visit:
www.commerce.wa.gov.au/ScienceInnovation
or call +61 8 9282 0777.

Northern Territory Government

# OPPORTUNITIES IN AUSTRALIA'S NORTHERN TERRITORY



- **1.346 million square kilometres of land and 6000 kilometres of coastline**

- **Rich biodiversity across, marine, coastal, freshwater, tropical wetland, woodland and desert habitats.**

- **A wide range of environments.**


## A diverse and rich resource for biodiscovery – Australia's Northern Territory

Australia's Northern Territory offers:

- 1.346 million square kilometres of land and 6000 kilometres of coastline
- A wide range of environments
- Rich biodiversity across, marine, coastal, freshwater, tropical wetland, woodland and desert habitats.

However, less than one per cent of the Northern Territory's land has been altered from its original form leaving much of the area's land mass and seas biologically unexplored.

Despite its reputation for remoteness, wild scenery and abundant biodiversity, Australia's Northern Territory has a sophisticated research community supported by a Government that values both conservation and development. The main strength of Australia's Northern Territory lies in its world leading Governance framework for the access and use of its many antique, rare and unique biological resources for the purposes of biodiscovery. Since its enactment this framework has attracted researchers and investors from around the globe interested in investigating the rich biodiversity of Australia's Northern Territory.

For more information on biotechnology and a range of other investment opportunities in Australia's Northern Territory visit www.investNT.com.au or email: biotechnology@nt.gov.au

www.investNT.com.au

# Biotechnology in Australia's Northern Territory

Australia is one of 17 megadiverse countries identified by the United Nations Environment Program. It has 10 per cent of the world's species, with 80 per cent of that biodiversity endemic to Australia, and often ancient, unique or rare. Up to half of Australia's species are yet to be identified.

The Northern Territory, in particular, plays host to a wide range of environments rich in biodiversity across freshwater, marine, tropical wetland and desert habitats, and is one of the last places in the world where wild rice can be found in situ.

The Territory, with 1.346m square kilometres and 6000Km of coastline, is the size of Spain, France and Italy combined. Less than one per cent of the Territory's land has been developed. This, combined with its small population of 227,000 people means that much of the Territory's land mass and seas remain biologically unexplored.

The Northern Territory Government regards the use of its biological resources for scientific, research and commercial purposes an appropriate use of its aquatic and terrestrial wildlife.

To facilitate the process of biodiscovery, the Northern Territory Government has passed the Access to Biological Resources Act 2006. The Act provides an open, enabling and transparent framework that is fully compliant with the Convention of Biological Diversity and the Bonn Guidelines. When combined with the ability to issue Certificates of Provenance for samples and extracts, our framework is able to provide a level of certainty and attractiveness to global and domestic biodiscovery organisations that is not commonly available elsewhere.

As such, our unique biodiversity coupled with our policies and legislation gives the Territory a strong point of differentiation. Our governance framework enables us through our access and benefit-sharing agreements, to provide an acceptable mechanism to allow Indigenous Territorians to share their traditional knowledge and potentially benefit from this new aspect of biotechnology. The Act and policies have been used as reference documents by several national and international jurisdictions.

The preservation of the Territory's biodiversity will continue to have commercial benefits.

Despite its small population, the Territory is home to a sophisticated research community. This includes Charles Darwin University, the Menzies School of Health Research, research facilities of the CSIRO, the Australian Institute of Marine Science (AIMS) and the recently-formed Bioscience North Australia Consortium. Research and commercial development in the Northern Territory is further supported by Australia's world-class intellectual property system and its broad experience in international commercial law.

*For more information on biotechnology and a range of other investment opportunities, visit* www.investNT.com.au
*Email:* biotechnology@nt.gov.au
*Ph. +61 8 8999 7162.*

## WILD RICE LIVES THROUGH ART

**Wetlands in Australia's Northern Territory are one of the few places in the world where wild rice has not been cross-bred and researchers from across the world visit the Northern Territory to access this resource.**

**Mitsuaki Tanabe is a Japanese artist, sculptor and conservationist who has chosen as the theme for his work the 'in situ conservation of wild rice'. His unique sculptures aim to inspire an awareness of the need for conservation and the co-existence of human life and wildlife.**

**For the last 20 years Mr Tanabe has been producing artworks that advocate the conservation of wild rice in its natural habitat if it is to exist in a future that faces growing demand and production of commercial rice.**

Part of Mr Tanabe's dedication to the conservation of wild rice at Mount Bundey.

**Mr Tanabe has undertaken work at Mount Bundey in the Northern Territory to carve ancient granite boulders with images of wild rice and other native species of animals and plants. He has also mounted a gigantic stainless steel sculpture of a lizard at Queensland's Mareeba Wetlands Centre as a reminder to visitors of the importance of environmental conservation. Both projects have carried out in cooperation with local authorities and with the approval of the aboriginal community. The works are entirely funded by Mr Tanabe and his Japanese supporters as a gift to the people of Australia.**

Department of **Employment, Economic Development and Innovation**

# **Queensland, Australia:** fostering international collaboration

Because top research drives innovation and impact, the Queensland Government has invested $3.6 billion since 1998 to position Queensland as a major research and innovation hub in the Asia Pacific region.

Outstanding talent, future leaders and knowledge precincts make Queensland a partner of choice.

Queensland businesses and research organisations are ready to form partnerships in:

- Agriculture
- Alternative and renewable fuels
- Aviation and Aerospace
- Biotechnologies
- Creative industries
- Environmental and mining technologies and services
- Information and communication technology
- Nanotechnology
- Therapeutic medicines and devices
- Tropical expertise.

Queensland Government funds enable Queensland researchers and businesses to actively seek out global partnerships and alliances.

**If you are interested in partnering with Queensland, visit science.qld.gov.au**

SD6075 06/10

Tomorrow's Queensland: strong, green, smart, healthy and fair

Toward 2 Tomorrow's Queensland

Queensland Government

# Queensland growth through partnerships

Queensland is actively building on its strengths in creating a vibrant innovation hub, stimulating business growth and creating business investment.

The State of Queensland has one of the fastest growing economies in Australia and the State Government aims to increase the proportion of Queensland businesses that undertake research and development or innovation by 50 per cent. The Government develops and makes the best use of international partnerships to optimise investment in research and innovation.

Since 1998, over A$3.6 billion has been invested in science, research and innovation. Strategic investments have created world-class R&D Centres of Excellence that form part of a comprehensive and collaborative network of infrastructure and precincts.

It is not only Queenslanders who will benefit from these investments. Queensland researchers are using their expertise to tackle global challenges in areas such as health, environmental management, primary industries and tropical living.

The Queensland Government has an integrated approach to fostering innovation with five key focus points:

- nurturing education – addressing the challenge to meet the growing demand for a highly-skilled, well-trained workforce;
- facilitating R&D – recognising that successful innovative companies build on the work of world-class R&D Centres of Excellence;
- fast-tracking product development – assisting organizations to fast-track and translate their research into products and services for the world market;
- stimulating business growth – supporting existing innovative businesses and promoting the growth of new ones;
- creating investment opportunities – by positioning the state's companies to attract investment by enhancing their investment readiness.

The Queensland Government's International Collaborations unit develops strategic research partnerships with overseas counterparts. The unit identifies priority areas for collaboration, leads Queensland's participation in international partnerships in science, technology and design, provides advice to the Queensland Government about international collaborations policy, and support and coordinates fellowships and other collaborative research opportunities. Established partnerships include:

Indo-Queensland science collaboration – working with the Indian Ministry of Science and Technology to foster international research links in biotechnology, climate change, environment and energy since 2008.

Queensland-China partnership – working with the Chinese Ministry of Science and Technology and the Chinese Academy of Science to foster international research links and joint research programs since 2008.

Queensland-Smithsonian Institution relationship – advancing areas of mutual interest with the Smithsonian Institution, including in research, design, education and culture since 2000.

The UK Climate Change partnership – working with the Met Office Hadley Centre for Climate Change and the Walker Institute for Climate System Research since 2007.

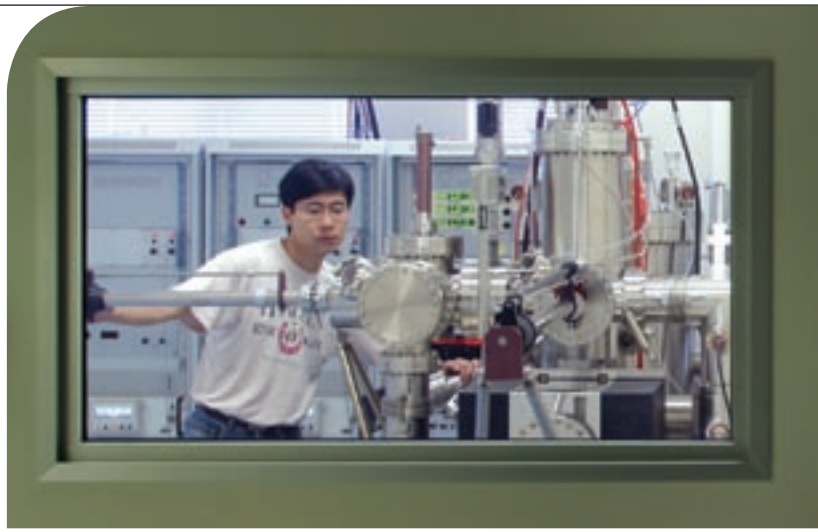
Building new collaborations through the Queensland International Fellowship (QIF) program – these fellowships are awarded annually to foster collaborative projects of Queensland researchers with key international knowledge partners.

www.science.qld.gov.au/international

**The Queensland Government provides products and services to the following industries/sectors:**

- Neuroscience – through the Queensland Brain Institute.
- Health – Institute of Health and Biomedical Innovation brings together leading health, science and biomedical engineering researchers.
- Molecular science – Institute for Molecular Bioscience conducts research into genes, proteins and small molecules of animals and plants, for the development of new pharmaceuticals, cell therapies and diagnostics for human health.
- Nanotechnology – Australian Institute for Bioengineering and Nanotechnology (AIBN) integrates the skills of 360 engineers, chemists, biologists and computational scientists in its commitment to translating research into commercial outcomes.
- Biopharmaceuticals – Translational Research Institute (opening Brisbane, 2012) will be a one-stop-shop for discovery, production, clinical testing and manufacturing of new biopharmaceuticals.
- Cancer and immunology – Diamantina Institute addresses issues such as cancer biology and immunology.
- Therapeutics – Mater Medical Research Institute (MMRI) is a world leader in the field of biological therapies.
- Drug discovery – Eskitis Institute sources new medical drugs from nature.
- Medical research – Queensland Institute of Medical Research (QIMR) researchers are investigating the genetic and environmental causes of numerous diseases, as well as developing new diagnostics, better treatments and prevention strategies.
- Tropical forests – the Australian Tropical Forest Institute in Cairns promotes the commercial and sustainable development of the biodiversity contained in tropical forests.
- Tropical innovation – the Australian Tropical Science and Innovation Precinct positions Australia as a pre-eminent provider of knowledge and research to industries and communities in the world's tropical regions, particularly in the Asia-Pacific.
- Agriculture – Queensland Alliance for Agriculture and Food Innovation (QAAFI), a new research institute at The University of Queensland, will initiate world-class research into agricultural innovation.
- Aeronautics – Australian Research Centre for Aerospace Automation is a collaborative project between the CSIRO and the Queensland University of Technology, which focuses on civilian uses for Unmanned Aerial Vehicles (UAVs).

# QUANTUM Computer Technology



The 21st century will be the quantum century, as scientists and engineers learn to apply the properties of quantum physics to developing powerful and radically new technologies for transmitting and processing information. Australia has built a critical mass of researchers and infrastructure in quantum computing and in quantum communications that is recognised internationally as one of the largest coordinated efforts of its type in the world.

## Centre description and history

The Centre for Quantum Computer Technology (CQCT) is a nationally co-ordinated effort to undertake research on the fundamental physics and technology of building both a solid state quantum computer in silicon and an optical quantum computer. It was one of the inaugural ARC Centres of Excellence in Australia and is headquartered at the University of New South Wales in Sydney, comprising six Australian universities, including the University of New South Wales, Melbourne, Queensland, Macquarie, Sydney and Griffith Universities. Currently there are 17 Programs with ~170 members (including academics, researcher fellows, ~70 PhD students, Master and Honours students, administration and technical staff). The Australian Research Council has just announced a further seven years of funding for this Centre to extend from 2011 to 2018 and to unite our research efforts in quantum computation and communications, including researchers at the Australian National University. This new Centre will be called the Centre for Quantum Computation and Communication Technology (CQC$^2$T). One of the main strengths of this Centre, in addition to outstanding research, is its strong and expanding international linkages.

## International Centre linkages

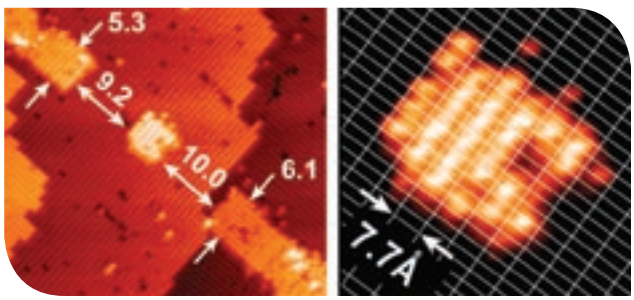
The Centre has developed important strategic linkages and exchanges personnel with: Sandia National Laboratories through a Cooperative Research and Development Agreement (CRADA); Purdue University, University of Madison-Wisconsin, University of Maryland, Hewlett Packard (Palo Alto and Bristol); IBM; Zyvex Laboratories, QuintessenceLabs, Harvard University, Princeton University,

### BEYOND 2010: THE CENTRE FOR QUANTUM COMPUTATION AND COMMUNICATIONS TECHNOLOGY (CQC$^2$T)

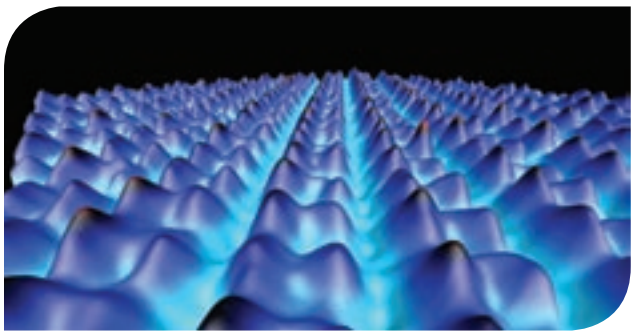
The Centre for Quantum Computation and Communication Technology (CQC$^2$T) will develop the science and technology of a global quantum information network, encompassing ultra-fast quantum computation, absolutely secure quantum communication and distributed quantum information processing. In particular it will:

- deliver key component technologies for both quantum computation and quantum communications;
- demonstrate the essential elements of a scalable quantum processor in silicon and a multi-qubit quantum computer based on optical technologies;
- develop an unconditionally secure communications technology based on long-distance quantum cryptography.

Ultimately CQC$^2$T will be seeking to develop the science and technology that could underpin a global quantum information network.

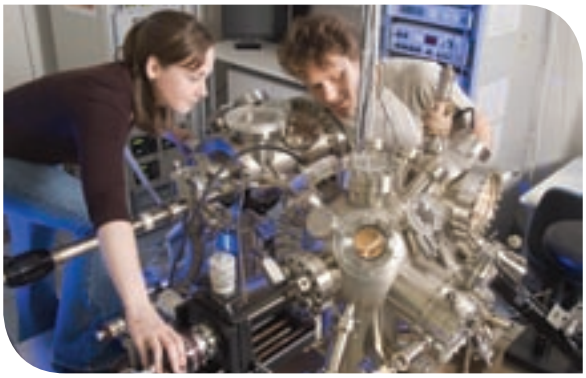



Scanning tunneling microscope image of the world's smallest precision built transistor. This image shows the source and drain leads to a small quantum dot with just 7 phosphorus atoms in it.



A clean Si(100) surface imaged by a scanning probe microscope.

> quantum communications allows the possibility of sending a secret key through a quantum channel, thereby augmenting classical communications protocols to allow unconditionally secure communications



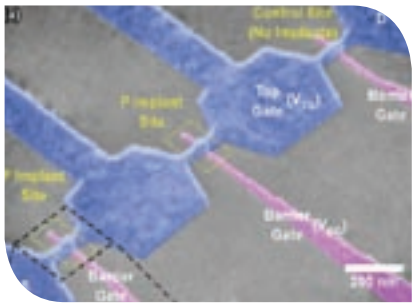
ABOVE: The unique combined molecular beam epitaxy crystal growth system (left) attached to the scanning probe microscope for single atom manipulation (right) is used to make atomically precise qubit devices.

RIGHT: A scanning tunneling microscope used to place single P atom qubits in silicon with atomic precision.

University of Illinois, UC-Santa Barbara, UC-Berkeley, Stanford University, University of Notre Dame, Texas A&M University, Louisiana State University; Cambridge University, Oxford University, University of Munich, the Walter Schottky Institute, University of Innsbruck, Neils Bohr Institute, the Perimeter Institute, National University of Singapore, University of Tokyo, National University of Taiwan and the European FP6 'Qubit applications' and FP7 'AFSiD consortium'. In addition the Centre has been supported by the National Security Agency (NSA)/Army Research Office (ARO) since 1999 for its work on silicon based quantum computing and independently through the National Security Agency (NSA)/ Intelligence Advanced Research project Agency (IARPA) for its work on optical quantum computation.

## Quantum computation and communications: Why are they useful?

Conventional computers struggle when the number of variables in a problem are large, or when the computer must search through a huge number of different possible solutions. Quantum computers promise an exponential speed up in computational power for certain types of problems with important applications in encryption and decryption of information (coding); fast database searching; modeling quantum systems; weather forecasting; economic modeling; scheduling/ timetabling of complex tasks. Quantum communications allows the possibility of sending a secret key through a quantum channel, thereby augmenting classical communications protocols to allow unconditionally secure communications. Bringing these together lies in the future of quantum information processing with important national security and economic impacts.



Coloured scanning electron microscope image of a tri-barrier nano field effect transistor where we can measure the transport spectrum of individual phosphorus dopants.

## Research output and highlights

Since 2000 the Centre has published 850 publications, 22 books/book chapters, ~20 patents and more than 1500 conference presentations, this includes papers in *Nature*, *Nature Physics*, *Nature Nanotechnology*, *Nature Photonics* and in *Physical Review Letters*. Among its key results are: read-out of a single electron spin on a P atom in silicon (*Nature* 2010); demonstration of the world's smallest transistor made with atomic precision (*Nature Nanotechnology* 2010); first demonstration of quantum chemistry on a optical quantum computer (*Nature Chemistry* 2010); demonstration of three qubit gate (*Nature Physics* 2009); highest precision measurement with photon qubits (*Nature* 2007); demonstration of an all-optical quantum CNOT (*Nature* 2003); development of an efficient scheme for linear optics quantum computing (*Nature* 2001) (see our website at http://www.qcaustralia.org/). Going forwards the Centre will be bringing in key expertise in quantum communications who have recently shown world leading technology in quantum memory (*Nature* 2010); heralded noiseless linear amplifiers (*Nature Photonics* 2009) and demonstration of a complete bright source quantum key distribution system (*Physical Review Letters* 2004/2005).

*Professor Michelle Y. Simmons,*
*Director, Centre of Excellence for Quantum Computer Technology*

# School of MATHEMATICS & STATISTICS

The University of New South Wales

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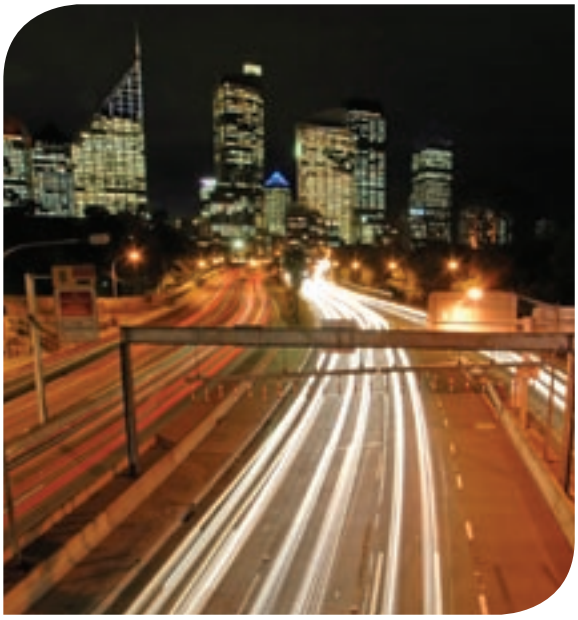
# Making maths and industry add up



"The mathematical sciences are going through a period of intense intellectual growth. Spectacular developments are being reported in all areas of mathematics and statistics, be they continuous or discrete, deterministic or probabilistic. Unexpected connections have emerged between seemingly disjoint areas of the disciplines."

*Report on Mathematics in Industry, Global Science Forum, Organisation for Economic Co-operation and Development, July 2008.*

Scientific and technological innovation requires a deep intellectual understanding of mathematics in all its areas in an environment that promotes links with industry and commercial partnerships. Such an environment can be found in the School of Mathematics and Statistics, at the University of New South Wales, (www.maths.unsw.edu.au) Sydney. This is the largest School of Mathematics and Statistics in Australia. The research activities of the School range across almost all areas in Applied Mathematics, Pure Mathematics and Statistics and it has particular strengths in algebra, biomathematics, biostatistics, complex systems, computational mathematics, discrete mathematics, dynamical systems, financial mathematics, geophysical fluid dynamics, mathematical physics, modern analysis, optimization and stochastic processes.

The School of Mathematics and Statistics is an internationally recognised leader for mathematical research in the Asia-Pacific region as measured by citations per paper and total numbers of citations. On the strength of this reputation the School hosts many International Scientific Meetings and was recently chosen to host the inaugural Pacific Rim Mathematics Conference in 2009 and the 6th Dynamics Days Asia Pacific Meeting in 2010.

The School has an active PhD program. Scholarships and exchange programs are available for international students.

In recent years the School has been building on its fundamental research strength to develop mathematically based decision technologies for Industry, Business and Government. Recent projects include scheduling, modelling and optimization of patrol boat activities with Defence Science and Technology Organisation (DSTO), modelling ceramic injection moulding processes for ear implants with Cochlear Ltd, designing micro-simulation traffic models for the Roads and Traffic Authority of NSW (RTA), examining the impact of recidivism on resource consumption with the NSW Department of Justice and Attorney General, and using extreme value theory to predict ground movements caused by coal mining with Mine Subsidence Engineering Consultants (MSEC). Many other projects are carried out in the School as host for the Sydney node of the ARC Centre of Excellence for Mathematics and Statistics of Complex Systems (MASCOS). This centre brings together mathematical scientists in the fields of critical phenomena, dynamical systems, stochastic processes, probability and statistics, algorithms, optimisation, network analysis and climate processes to address key problems that are of immediate and long-term relevance to the development, protection and wellbeing of the Australian people.

The School has established partnerships with other leading research centres in mathematics including: Mathematics for Key Technologies, Matheon, Technische Universitat, Berlin; MITACS Inc, Canada Network of Centers of Excellence; PIMS, Pacific Institute for Mathematical Sciences; CMM Centre for Mathematical Modelling, Universidad Chile. The School also has collaborative agreements with over 100 international universities and each year it supports collaborative research visits of a few weeks duration by approximately 80 mathematicians from around the world.

Research in the School is carried out by more than 100 academic and research personnel, the School has state-of-the-art computing facilities for numerical and symbolic computation and is housed in a modern building, about 10km from the Sydney International Airport, 10km from the Sydney CBD and just a few kilometres from famous Sydney surfing beaches. ■

# EUROPEAN AND UQ
## physicists shoot for the stars

University of Queensland physicists are driving European collaborations, taking quantum science and astrophysics to new heights.

Professor Gerard Milburn has partnered with experts from universities in Italy, United Kingdom, Germany, Austria, Slovakia and Japan to advance quantum computing.

The project, called Hybrid Information Processing (HIP), began in November 2008 and will run until November 2011.

Professor Milburn said HIP aimed to unleash the power of quantum computers.

"What takes a billion switches in a conventional computer can be done with a few hundred quantum switches or quantum bits in a quantum computer – so just imagine the power of a few billion quantum transistors," Professor Milburn said.

"But the problem is that quantum bits are vastly more sensitive to imperfection than classical transistors.

"So we're exploring how to increase the number of quantum bits without the effects of these imperfections leading to an exponential cascade of errors."

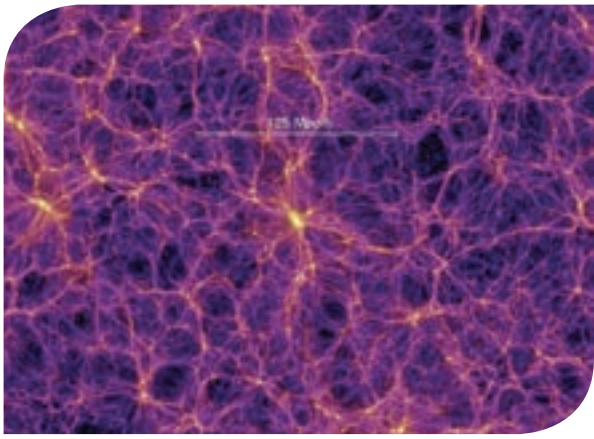
Professor Milburn said the value in joining European projects was that it allowed direct access to some of the world's leading research groups in quantum information.

"We share all the results of the project between partners, so the benefit in knowledge transfer to my research group at UQ is incredibly valuable," he said.

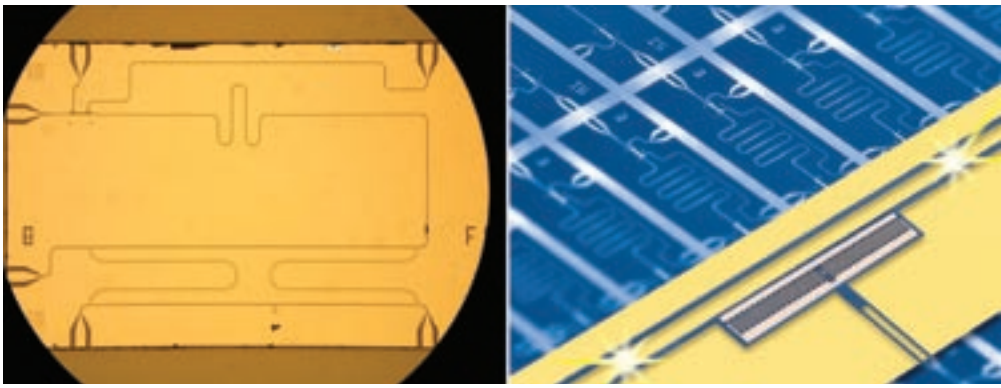
"I have visited a number of the participating partners over the last 12 months.

"We also welcome a number of the collaborating researchers to join our group from time to time – that's of particular benefit to our PhD students, who get an opportunity to interact with a far wider research group than they otherwise would."

Professor Milburn also began The Atomic QUantum TEchnologies (AQUTE) Integrating project in November 2009 with the University of Aarhus in Denmark, Technical University in Vienna, ETH in Zurich and Ulm University, Germany.



Simulation of the cosmic web.



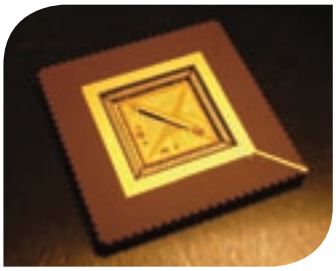
A superconducting quantum circuit from the European collaborator, Andreas Walraff, in Zurich. Milburn is developing theoretical models for Walraff's experiment.

The project aims include developing quantum technologies based on atomic, molecular and optical systems for scalable quantum computation and entanglement-enabled technologies, such as metrology and sensing.

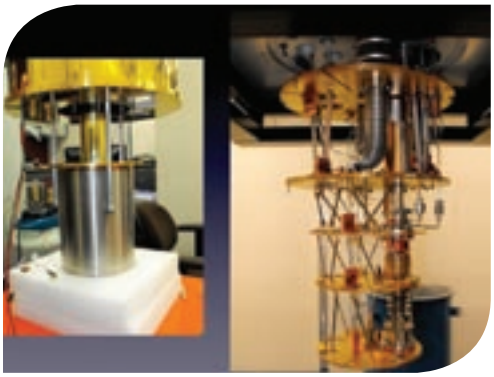
"We also aim to establish new interdisciplinary connections to reinforce interdisciplinary links at the frontiers of quantum information science and other scientific fields, as well as conceive and realise novel hybrid systems," Professor Milburn said. "Knowledge transfer will enable our own lab in this area to remain internationally competitive," he said.

> "quantum bits are vastly more sensitive to imperfection than classical transistors, so we're exploring how to increase the number of quantum bits without the effects of these imperfections leading to an exponential cascade of errors"

M92 which is a globular cluster in the Hercules constellation, 26000 light-years from Earth containing over a million stars. The origin and evolutionary history of globular clusters such as these are the primary topics of Brendan Griffen's PhD.



ABOVE: A novel device for trapping and controlling single atoms in the Laboratory of Schmidt–Kaler in Ulm. Milburn has developed theoretical schemes for simulating physics in these devices.



BELOW: Pictured is a dilution fridge rig in UQ's superconducting quantum circuit lab, which is a similar piece of equipment used by Professor Milburn's European collaborators.

It is not just UQ's work in the area of quantum science that is advancing by leaps and bounds thanks to European partnerships, but also its research in astrophysics.

UQ PhD student Brendan Griffen has partnered with European researchers to unlock the mysteries of celestial objects in the universe.

Mr Griffen aims to explain how globular star clusters and ultra-compact dwarf galaxies have formed around most galaxies.

To achieve this, Mr Griffen is tapping into international collaboration, Virgo Consortium, which consists of 60 researchers across six countries, primarily the UK, Germany, Netherlands, Canada, the USA and Japan.

"During my PhD, I am using the data from some of the highest-resolution simulations of the universe ever done to date," Mr Griffen said.

"Due to the inherent computational difficulties involved in simulating the Universe, the project has grown to become a multinational and multi-institute enterprise."

The collaboration mainly involves the Institute for Computational Cosmology attached to UK's Durham University and Max-Planck Institute for Astrophysics in Garching, Germany, as well as a number of satellite institutions in Canada, Japan, Netherlands, Scotland and the USA.

Mr Griffen began the research project in March 2008 with the support of a UQ postgraduate research scholarship.

The research involves three simulations widely known in the astrophysics community as Aquarius (which simulates our Milky Way Galaxy, finished 2008), Millennium (which simulates the entire Universe, finished 2005) and Millennium-II (which simulates entire clusters of galaxies, finished 2009).

"Each of the Millennium simulations contain over 10 billion particles and took one month to complete on some of the world's fastest supercomputers," Mr Griffen said.

"My research involves using these simulations to test star cluster formation models in the early Universe.

"I collaborate weekly with researchers within the Virgo Consortium to refine my models and improve on the existing theoretical framework."

Aside from information sharing, the collaborative project has also provided Mr Griffen travel opportunities.

He visited the University of Sussex and Durham University for two months last year.

"I have already once been over to Europe to collaborate more directly with researchers at the University of Sussex and Durham University and have found working with such experts a very rewarding experience," Mr Griffen said. ■

**10 billion**

**the number of particles in each of the Millennium simulations.**

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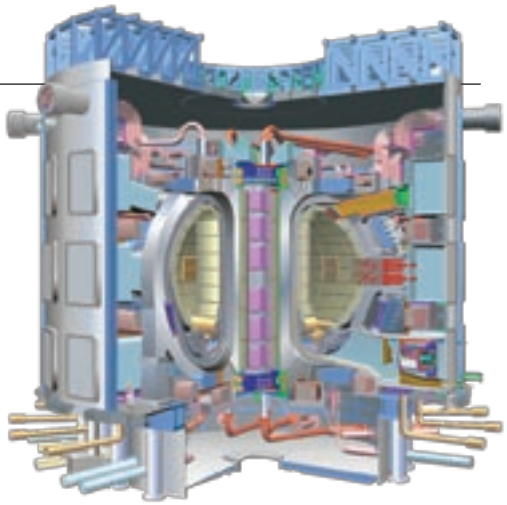
# Fusion provides answers



The confluence of rising $C0^2$ emissions with the recent oil crisis in the Gulf of Mexico is a poignant reminder of the damage our exploitation of fossil fuels are doing to our planet, both in their extraction and their combustion. Fossil fuels are only finite resources, and their cost will only rise over the long term.

Rather than focus the debate on managing dwindling fossil fuels, politicians of all flavours could simply accept there are no long term energy solutions, and look to social policy measures to modify behaviour, and global science quests to develop long term sustainable technological solutions.

On the policy side, we could implement a whole raft of measures: from increasing the rebate on hybrid cars to improving public transport and its utilisation, and encouraging the greater use of bicycles and indeed, our own two feet.

Increased energy research funding could target replacing our fossil economy, for example, by improving fuel cells efficiency and taming new sustainable energy sources such as fusion and solar to power a hydrogen economy.

One of these sustainable energy technology, fusion, is being "fast-tracked" by an international consortium of partners building the world's first "burning plasma" fusion experiment, ITER (International Thermonuclear Experimental Reactor), which is designed to test the scientific feasibility of fusion power.

Fusion is the process whereby lower atomic weight elements join to form a heavier element. This is the fundamental process that powers the Sun and the stars. Fusion energy promises millions of years of baseload energy generation, with almost no greenhouse gas emissions and no long-lived radioactive waste compared to coal and nuclear fission. Development of this energy technology requires committed multilateral programs, and ITER is the only viable global program to achieve this objective.

Image courtesy of Newscientist, vol 188, no. 2525

ITER is funded by a consortium comprising the EU, Japan, the USA, Russia, India, China and Korea. At a cost of US$18 billion, ITER is also the world's largest science experiment. The host for the ITER experiment is the EU, with the host site in France.

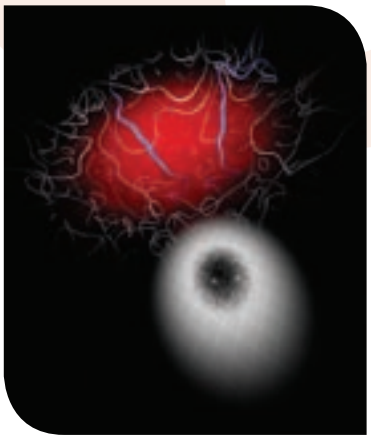
Australia has an opportunity to engage in the ITER project through the construction of a targeted machine contribution, most likely a plasma diagnostic. This would realise objectives of the Australian science and engineering community in its 2007 strategic plan (www.ainse.edu.au/fusion.html), and build on opportunities provided by the 2009 $7m federal research infrastructure investment in the Australian Plasma Fusion Research Facility at the ANU. The major benefits to Australia from engagement with ITER include participation in the global development of a long-term energy solution, capability development in the research phase leading up to commercial realisation and engagement with world's largest science project. Wider benefits include fostering international research linkages, skills and training, supporting other power technologies (e.g. fission, solar) and the promotion of Australia's minerals and high-tech industry.

Participating in global efforts to find alternate solutions to fossil fuel won't plug the leak in the Gulf of Mexico, but it might eliminate the need of our species to drill in the first place.

*Dr Matthew Hole, is an ARC Future Fellow from the Research School of Physical Sciences and Engineering at the ANU, and Chair of the Australian ITER Forum.*

# QUANTUM SCIENCE builds global connections

A 3D rendering of a Bose-Einstein condensate (BEC) containing vortices soon after it forms, with a shadow image underneath.



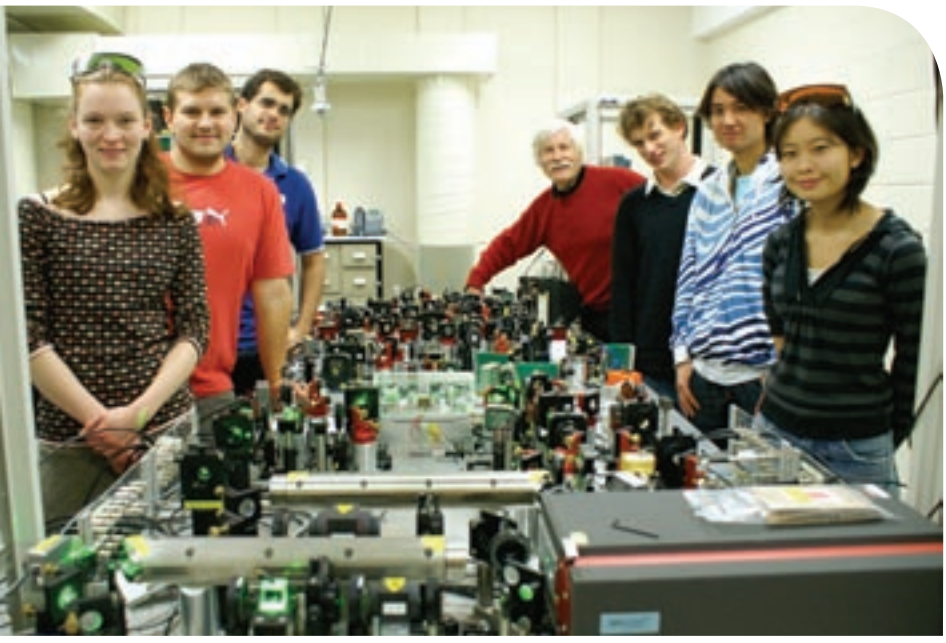
Quantum-Atom Optics forms the foundation of future technologies. In a similar way that optics and electronics shaped the technologies we have today, we are convinced that quantum concepts will influence and improve communication, sensing, navigation and exploration within a few decades. The evolution of this field involved basic theory and Gedanken experiments of the 1930s, first experimental demonstrations in the 1990s and refined systems and theory models in the present, leading to actual devices in 2020-2030. This process of innovation will accelerate and ultimately create major new industries. This trend has been recognised around the world. In Australia this is a research field of extraordinary strength.

The ARC Research Council Centre of Excellence for Quantum-Atom Optics (ACQAO) has been one of the first to link the diverse techniques of optics, photons, ultracold atoms and coherent matter waves. Our strength is that we understand and can demonstrate the special quantum properties of large objects, involving thousands or even millions of atoms or photons, and observe the transition from the microscopic world of few particles to the macroscopic classical world. We start with systems dominated by quantum effects and investigate, step by step, the way quantum rules extend to practical systems.

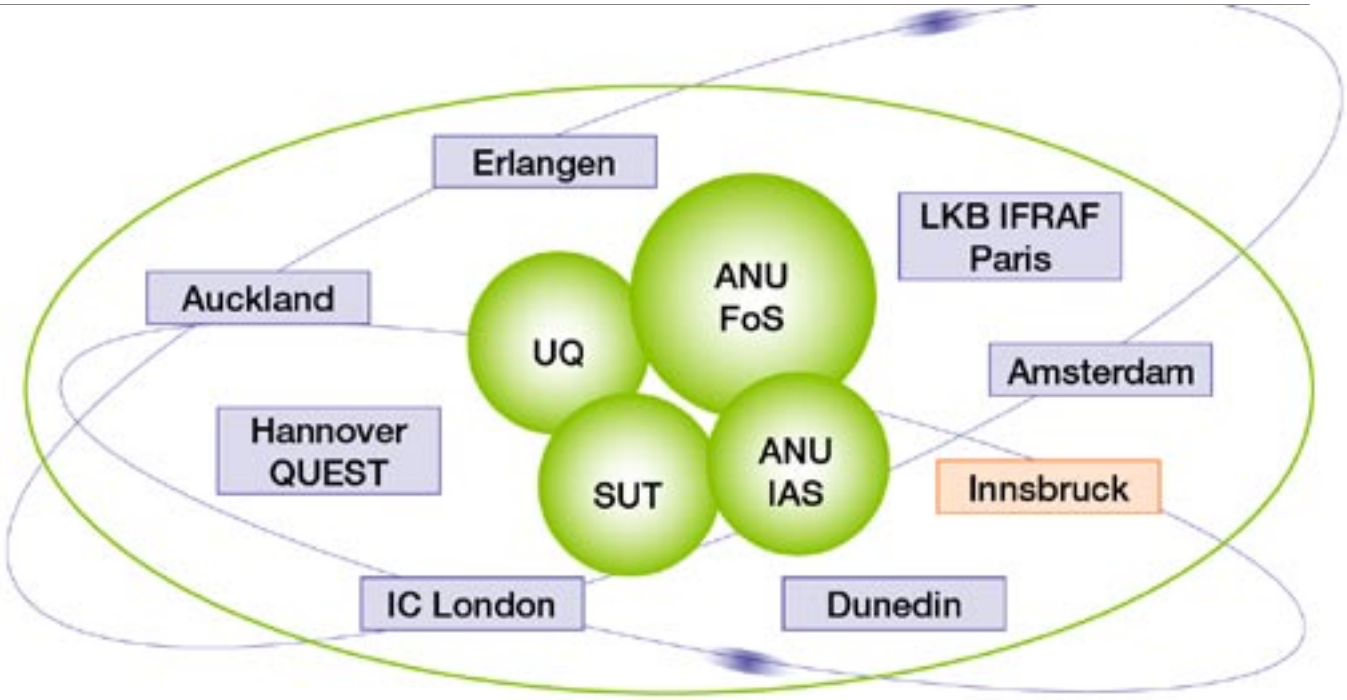
ACQAO was founded in 2003 and has expanded the expertise through a series of ambitious goals, both in theory and experiments, and succeeded in achieving every single one of them. At the same time we have trained a group of outstanding young scientists who will take our science to the next level and across the world.

ACQAO combines the skills and experience of many of the most productive Australian researchers in this field. We bring together experienced leaders in the field with successful younger researchers and with a highly talented and motivated group of graduate students. Reaching far beyond individual projects, ACQAO has built links across Australia and created a network with our international partners, in particular in five European countries: Germany, France, United Kingdom, Holland and Denmark. The close collaboration includes the sharing of ideas and experience, joint workshops and the exchange of students and staff.

Collaboration brings many highlights. For example, we have several cotutelle students and staff exchanges between ACQAO@ANU and Universite Paris VI in the area of quantum imaging and multimode quantum optics, which is fundamental research that explores the foundation and limits for future quantum communication and optical metrology (see photo left). By combining experiments in Australia with theory in France we have become a leader in this field. This collaboration is one of the central features of the current European FP7 research program HIDEAS[1],



The international q-Imaging team (from left: Kate Wagner ANU, Jiri Janousek – ANU – Czech Republic, Jean Francois Morizur – Cotutelle ANU – Paris, Pu Zian – ENS Paris, Seiji Armstrong ANU, Lachlan Niccols ANU, Hans Bachor ACQAO).




> a very efficient network has allowed us to combine experimental expertise, technology and ideas from both continents and create opportunities for new generation of scientists

which explores the roles of quantum entanglement in future IT systems. In parallel we had student exchanges with the Danish Technical University (DTU) in Copenhagen.

We have an exchange of staff and students in the area of Bose Einstein condensates, atom lasers and atom interferometers with two of the leading research Centres in Europe. IFRAF (Institut francilien de recherche sur les atomes froids) in the Paris region[2] and QUEST (Centre for Quantum Engineering and Space-Time Research) in and around Hannover[3]. PhD students from both sides have participated in experimental projects in the other country. We have a cotutelle program with Paris and joint PhD projects with Amsterdam, Bonn and Hannover. Research staff is travelling forth and back.

In addition, we had many scientific exchanges between the ACQAO nodes in Brisbane, Melbourne and Canberra, with research teams in London, Innsbruck and Erlangen. Several Fedor Lynen Fellowships from the German Humboldt Foundation and international exchange programs funded by the ARC have supported our networks.

Since 2003 we have held an annual series of jointly organised workshops, alternating between Australia, France and Germany, which has created a very efficient network for our young staff (see photo, below left). This has allowed us to combine experimental expertise, technology and ideas from both continents and create opportunities for new generation of scientists. Several of the graduates now hold postdoctoral positions in European universities and are highly successful in their research.

Modern science is truly global. Our model of long distance collaborations has been adopted in the formation of similar Excellence Clusters, for example in Germany and France. We know that our intensive links are accelerating our research in quantum science and create a higher impact for our work. These collaborations are beneficial to all involved, they are stimulating and they give young scientists in Australia and Europe the best possible support for their future careers.

*Hans Bachor, Director and Damien Hughes, COO ACQAO, Canberra*

International workshops such as this held in the French Alps by IFRAF (France), QUEST (Germany) and ACQAO (Australia) bring together young scientists to discuss quantum and atom optics.

FOOTNOTES
1 HIDEAS http://hideas.dfm.uninsubria.it/
2 IFRAF http://www.ifraf.org/
3 QUEST http://www.questhannover.de/

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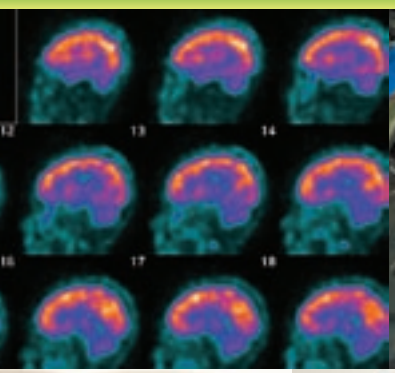
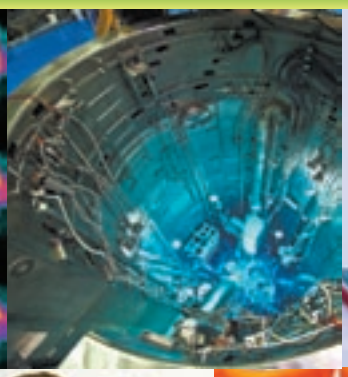

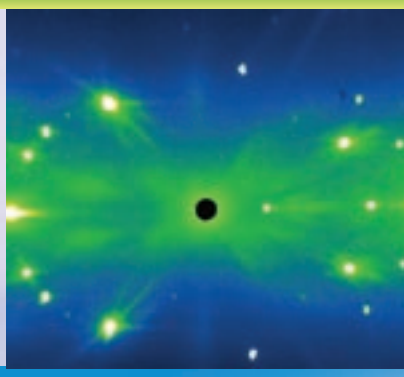



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# Green light for Australian/French nuclear science partnership

The CEO of the Australian Nuclear Science and Technology Organisation (ANSTO) Dr Adi Paterson has signed an agreement with his counterpart, Professor Bernard Bigot, head of the French Atomic Energy Commission (CEA). This means ANSTO and CEA will partner more widely in research areas such as nuclear medicine, life sciences, radiation therapy, safety and radiological protection.

The signing took place in early March 2010 at *The International Conference on Access to Civil Nuclear Energy* attended by 1400 delegates from across the globe. Opened by French President Nicolas Sarkozy, it is one of a series of conferences preceding the 2010 Non-Proliferation Treaty Review Conference.

"CEA, with more than 15,000 staff, is a leader in research, development and innovation in Europe. ANSTO has key research programs that have become possible because of our state-of-the-art OPAL research reactor and our unique accelerator capabilities, which make it mutually attractive to collaborate more intensively", Dr Paterson said.

OPAL reactor – the OPAL reactor facility has three parts:
1. OPAL reactor core and reflector vessel
2. Cold-neutron source and
3. Neutron guides and scientific instruments.
*Photo by: ANSTO www.ansto.gov.au*

Construction of OPAL-The reflector vessel is lowered into the reactor pool, under the watchful eye of the media. *Photo by: ANSTO www.ansto.gov.au*

ANSTO and the CEA first joined forces in 1992, signing a cooperation agreement on the peaceful uses of advanced nuclear technology. It enabled important collaborative projects in areas such as medical imaging, radioactive waste forms and environmental research.

ANSTO researchers have also been involved in climate and atmospheric pollution monitoring in Europe, as well as specialised medical imaging in collaboration with CEA. "It is crucial that Australia continues to have a seat at the European table", Paterson said.

In the last 18 months, ANSTO's Reactor Operations General Manager, Dr Greg Storr, has collaborated with his French counterparts who are building the new Jules Horowitz Reactor (JHR) at Cadarache in the South of France due for completion in 2014. Cadarache is fast becoming a key global nuclear innovation hub with a number of scientific mega-projects underway.

"Australia benefits greatly from engaging in international research and development collaborations", Dr Storr added. "Programs like these, which bring key skills, capabilities and facilities within the reach of Australian scientists, allow our experts to work in research activities of global significance. Our French colleagues are also keen to learn more about our cutting edge projects and in partnership use and develop state-of-the-art facilities. In this context it made sense to re-establish a strong and comprehensive research agreement."

> "our French colleagues are also keen to learn more about our cutting edge projects and in partnership use and develop state-of-the-art facilities"
>
> *– Dr Greg Storr, Reactor Operations General Manager, ANSTO*

Construction of the Jules Horowitz Reactor, the ITER (originally known as the International Thermonuclear Experimental Reactor) fusion reactor, and new funding for sodium cooled fast reactors received by CEA as part of a €1 billion French stimulus package, is clear evidence of the rapid expansion of nuclear science and technology globally. ■

# CSIRO
## driving 'southern skies' astronomy

Astronomy is one of Australia's strongest fields of science. In 2009 a new Australian optical telescope, the ANU's SkyMapper, opened its eye in northwest New South Wales. In 2010, the first antennas of CSIRO's Australian SKA Pathfinder, a next-generation radio telescope, are arising in the West Australian outback near Geraldton.

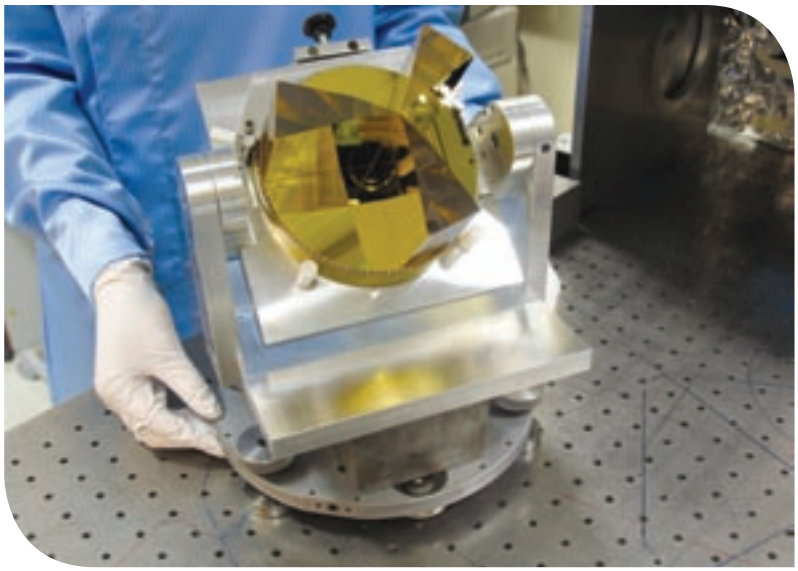
Australian facilities have generated papers in the top 0.1 per cent of the most highly cited astronomical papers for all time. A 2005 study – the most recent available – found that: Australian astronomy papers were cited more often than expected; that all Australian institutions with a significant astronomy output published at or above the world benchmark; and that most of the above were published in high-impact journals.[1]

How did we get to this position? Australian astronomy's strength is the result of interacting factors: our location, continuity of institutions (and the funding that supports them), good governance and good management – including the willingness to take risks and the ambition to do so.

Being in the Southern Hemisphere has been important. There's an abundance of special objects to look at: the centre of our Galaxy goes overhead here; our two neighbouring satellite galaxies, the Large and Small Magellanic Clouds, can only be seen from the south; we also have a unique view of the nearest galaxy with an active black hole at its centre, Centaurus A. Australia became the base for many projects to map and catalogue the "new" southern sky, from the ambitious Astrographic Catalogue and Carte du Ciel projects of the late 19th Century to decades of surveys by the UK Schmidt Telescope and the catalogues made with Australian radio telescopes from the 1960s.

Australia's distance from its European roots fostered self-reliance and the development of independent centres of technological expertise. This is particularly striking in the case of radio astronomy: the radio engineers CSIRO assembled to work on radar during World War II were kept together after the war, and began to investigate the curious radio signals that had been found coming from the Sun. They, along with their colleagues in the UK and the Netherlands, pioneered radio astronomy. Ambition, technical excellence and freedom to explore led the group to make great and rapid advances: they found the first radio sources known outside our own Galaxy (the galaxies Virgo A, Centaurus A and Cygnus A); they located the centre of our Galaxy; and they gained the first evidence of violent outbursts occurring in the Sun's atmosphere.

By the 1950s this strong local community of radio astronomers was in a position to conceive, commission and build CSIRO's Parkes radio telescope:



BELOW: **The Retro-Reflector, also called a Cube Corner:** CSIRO Industrial Physics has mastered the manufacturing technique for the retro-reflector, called a cube corner, at its Lindfield laboratories.

CSIRO's success with a new manufacturing technique for this piece of astrometry equipment is likely to help American scientists detect planets in our galaxy and beyond. Astronomers need telescopes that can make precise measurements down to thousandths of a millimetre, and the cube corner enables a level of accuracy not previously available.

Cube corners are made by bringing together ultra-smooth, ultra-clean pieces of Zerodur, a glass-like substance similar to ceramic hot plates. Zerodur knits together molecule by molecule in a process called optical contacting.

*Photo by: CSIRO Materials Science and Engineering.*

The first antenna of CSIRO's ASKAP radio telescope at the Murchison Radio-Astronomy Observatory in Western Australia. *Photo by: Phil Dawson, CSIRO.*

when opened in 1961, it was the second large dish of its kind in the world and the only one in the Southern Hemisphere. Similarly, the development of optical astronomy in Australia, particularly at Mount Stromlo Observatory near Canberra, was such that Britain was considering where to build a Southern Hemisphere telescope for its own astronomical community. Australia was not only a likely location but a suitable partner, and Australian optical astronomers, keen to catch up with their radio counterparts, agitated for it: Richard Woolley, Director of Stromlo and then Astronomer Royal in the UK, was a leading proponent. The telescope that resulted, the Anglo-Australian Telescope at Siding Spring Observatory, was equally funded by the UK and Australian governments, both in its construction and operation.

The opportunity to use these advanced new facilities drew talented people, from both inside Australia and abroad. Talented people and good technology created research success. Bob Frater, Chief of CSIRO Radiophysics in the 1980s, and responsible for building CSIRO's Australia Telescope Compact Array telescope, has noted three crucial factors in bringing this about: institutional directors who were not scared of challenges and who were prepared to take some risks; the ability to keep an organisation lean and efficient; and people who asked "why not do it?" rather than "why should we do it"? Examples of big, risky projects that paid off are the Australia Telescope Compact Array itself – brought in on time and on budget – and the Anglo-Australian Observatory's construction of the "Two-Degree Field" system to capture light with 400 optical fibres – a project that stretched the organisation to its limit, but which then formed the basis for some of its greatest scientific achievements.

> "Australia has an outstanding resource of "radio quietness", the quiet background necessary for detecting the faintest whispers from space – a resource that few other countries have"

The directions in which Australian astronomy has developed have been guided by careful consideration of Australia's relative strengths, technological and physical. In optical astronomy, Australia's relative strength lies in wide-field surveys (i.e. surveys of large areas of sky), particularly spectroscopic surveys (i.e. those in which light is collected from individual objects and analysed to determine their physical and chemical properties). In the radio, Australia has an outstanding resource of "radio quietness", the quiet background necessary for detecting the faintest whispers from space. This is a resource that few other countries have. Australian radio astronomers also have a depth of technical expertise that is allowing them to pioneer the technology needed for wide-field radio surveys – that is, ways to allow radio telescopes to see a large piece of sky at one 'glance' – which is even more challenging in the radio than in the optical. Australian astronomers also plan carefully for synergies between projects and indeed telescopes and instruments, each decade charting a course for the field's development.

Australia's strong history of success in astronomy has put it in a good position to create and host new instruments, such as CSIRO's Australian SKA Pathfinder Telescope, which is now under construction, and potentially the global SKA radio telescope itself. The SKA (Square Kilometre Array) will be a A$2.5 billion international science facility, an array of hundreds or thousands of collecting dishes. Described as astronomy's equivalent of the Large Hadron Collider, it will be one of the world's most important pieces of scientific infrastructure to be built this century. Australia and New Zealand are jointly vying to host the SKA, with the other contender being Southern Africa. The site for the SKA will be determined in 2012. Meanwhile, Australia is laying the groundwork locally with the Australian SKA Pathfinder, which has already made its first successful observations. ■

FOOTNOTES:

[1] A Bibliometric Analysis of Astronomical Sciences Publications. B. Biglia and L. Butler. Annex C1 to: New Horizons: A Decadal Plan for Australian Astronomy 2006-2015. National Committee for Astronomy of the Australian Academy of Science (2005).

# SCRAMSPACE: Scramjet-based Access-to-Space Systems

Safe, economical and environmentally responsible access to space is one of the major technological challenges of the 21st Century for all nations due to the dependence of the global economy on assured and secure access to space-based services. Actually getting there remains the single most important impediment to humankind's use of space for communications, positioning and timing, remote sensing, space science and so on.

The most promising way to meet this challenge is to extend aeronautical technology to hypersonic vehicles powered, at least partially, by supersonic combustion airbreathing engines (scramjets). Scramjets can be combined with rockets to produce a more fuel-efficient hybrid launch system.

Australia is a world leader in this field of research and development, with work being performed by a robust hypersonics community located in several universities, industry and the Defence Science & Technology Organisation (DSTO).

Australia's present focus is to achieve working concept technology demonstrators that can achieve scramjet-powered atmospheric flight at Mach 8. Two flight programs, HyShot and HIFire, are at the core of these efforts. The ultimate aim is to develop mature scramjets that can operate at much higher Mach numbers, to accelerate a vehicle to the speed required to leave the Earth's atmosphere. No scramjet designs have been flight tested at these extreme speeds before now. The gap cannot be easily closed in one leap, and a stepping-stone approach is required.

> "the ultimate aim is to develop mature scramjets that can operate at much higher Mach numbers, to accelerate a vehicle to the speed required to leave the Earth's atmosphere"

The first step in this process is being taken by a recently funded project called 'Scramjet-based Access-to-Space Systems', or SCRAMSPACE. SCRAMSPACE is a A$14m, 13-member international project led by The University of Queensland (UQ). The partners in the SCRAMSPACE consortium include: Australia's key players in hypersonics research – UQ, University of New South Wales, University of Adelaide, University of Southern Queensland and DSTO; local industrial partners BAE Systems, AIMTEK and Teakle Composites; international partners German Aerospace Center (DLR), Italian Aerospace Research Center (CIRA), Japanese Aerospace Exploration Agency (JAXA), and the University of Minnesota; as well as involvement from our young people through the Australian Youth Aerospace Association.

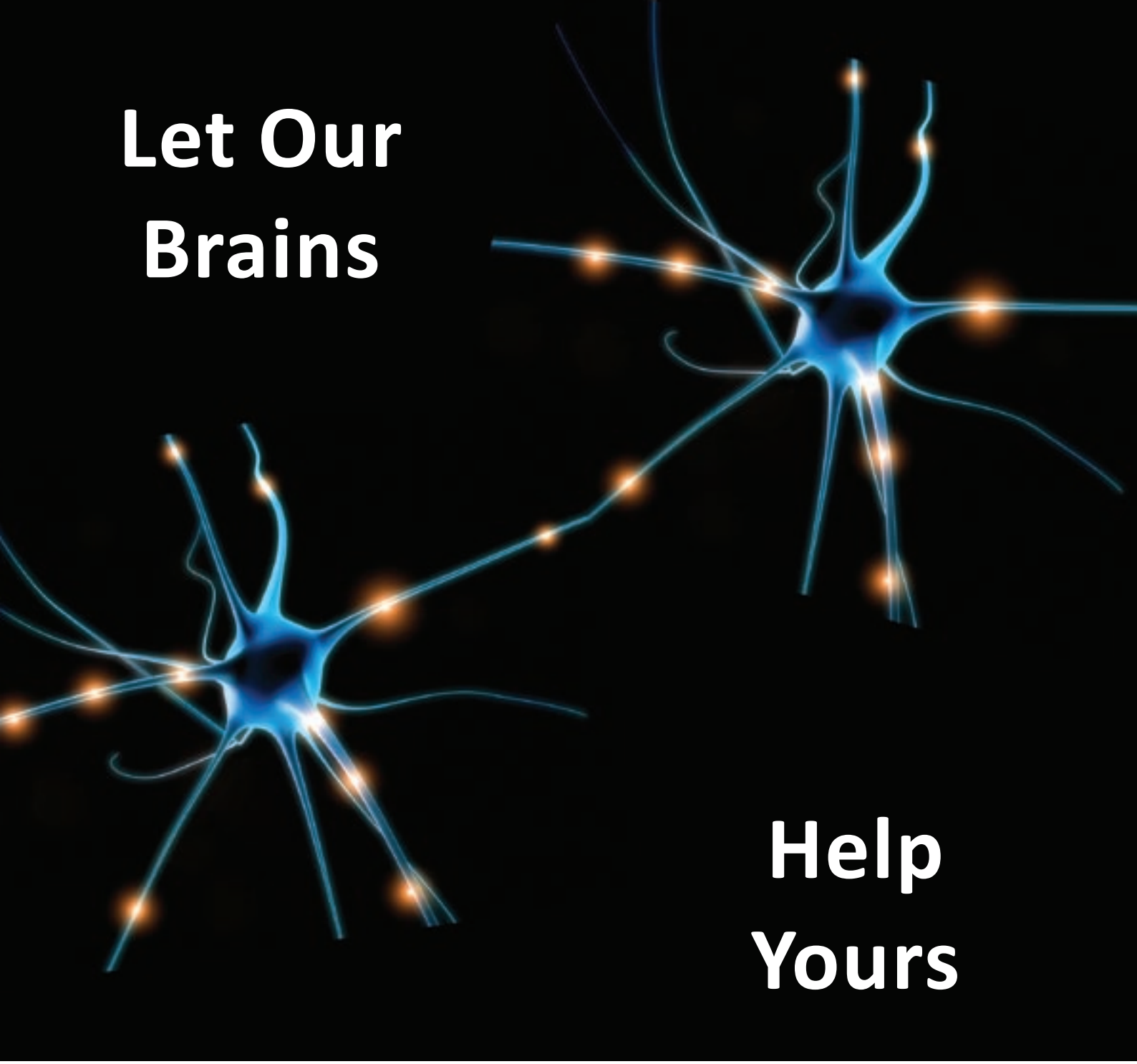
The Australian Government has invested $5m in SCRAMSPACE through the Australian Space Research Program (ASRP). A principal aim of the ASRP is to strengthen Australia's nascent space industry by encouraging collaboration between numerous small groups and centres, all of which have expertise but none of which has critical mass. SCRAMSPACE offers the prospect for Australia to develop a scramjet-based access-to-space industry and contribute to assured and secure access by Australia to space and space technology.

HyShot, along with HIFire, is at the core of the scramjet-powered atmospheric flight program.

The objectives of SCRAMSPACE are both scientific and strategic.

Firstly, the project will use hypersonic ground testing facilities, in particular the unique X3 expansion tunnel at UQ, to push the upper limits of scramjet operation for access-to-space purposes. X3 is the only facility in the world that can be used for testing reasonable scale scramjets at very high Mach numbers and at the actual dynamic pressures experienced by vehicles on ascent-to-space trajectories. This ground test research is innovative, will address key S&T questions for such ➤

# Let Our Brains



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scramjets, and will maintain Australia at the forefront of world scramjet research for access to space. It will underpin follow-on phases of the road map, in which increasingly high-speed and long-duration flight experiments are performed, leading eventually to prototype hybrid rocket/scramjet access-to-space systems. In the process, SCRAMSPACE will contribute to Australia's space science goals for the coming years, as detailed in the Decadal Plan for Australian Space Science 2010-2019.

Secondly, the project will deliver an advanced free-flying scramjet flight experiment, SCRAMSPACE I, at the entry point to the Mach 8-14 access-to-space range for scramjets. The inflight performance of an exciting, innovative and commercially-attractive scramjet concept being explored jointly by UQ and DSTO, as well as high temperature materials with embedded sensors, and novel laser-based flight instrumentation, will be demonstrated. In so doing, SCRAMSPACE will build an experienced and immediately-industry-ready team of flight scientists/engineers that will contribute to the talent pool for a future Australian access-to-space capability. Australian industry, at both small-to-medium-enterprise and large company level, will be directly involved to allow the project to benefit from industry capability and to permit industry to acquire enhanced skills, expertise and capacity.

SCRAMSPACE has been designed to gain maximum leverage of the complementary skills and capabilities of the international aerospace partners DLR, CIRA and JAXA. In particular, the very large ground test facilities in Europe such as CIRA's plasma hypersonic wind tunnel – to be used in this project for scramjet combustion chamber materials testing – and DLR's huge shock tunnel – to be used here for studying the performance of the scramjet designs at large scale – will be critical for answering certain key questions posed by the technology. Furthermore, both DLR and CIRA possess advanced high temperature materials capabilities for aerospace systems, and will contribute components to the scramjet flight experiment. DLR's Mobile Rocket Base will launch the rockets used to boost the scramjet onto its flight trajectory. External to the consortium, key European research groups will be kept informed of progress, and the door will be open for the development of related collaborations – in particular, with both ESA's European Space Research and Technology Centre (ESTEC) and the German Research Foundation (DFG) funded Graduate School (GRK) on the Aerothermodynamic Design of a Scramjet for Future Space Transportation Systems. ESTEC currently leads two European Community funded projects: ATLLAS (Aerodynamic and Thermal Load Interactions with Lightweight Advanced Materials for High Speed Flight) and LAPCAT II (Long term Advanced Propulsion Concepts and Technologies).

SCRAMSPACE will contribute to Australia's space science goals for the coming years, as detailed in the Decadal Plan for Australian Space Science 2010–2019.

SCRAMSPACE has a specific aim to encourage young people to study aerospace engineering and related disciplines and to look towards the Australian space sector for their career. Undergraduate students of the Australian Youth Aerospace Association, and through them senior high school students from across the country, will be exposed to the project through the annual AYAA workshops and fora.

In the long term, scramjet-based systems will be an enabling technology for access to space. Scramjet R&D is an area of Australian niche excellence and world leadership, and SCRAMSPACE capitalises on this in the first phase of the road map to the development of hybrid rocket/scramjet access-to-space systems. It may be possible to develop such systems within a domestic industry to be established, particularly for delivering small payloads to Low Earth Orbit. However, the strategic importance of projects such as SCRAMSPACE goes beyond the particular fields in which they are conducted – in this case, hypersonics and access-to-space systems.

The SCRAMSPACE project will help Australia to build strategic international partnerships with some key governments, research organisations and companies in the space-related sector. The knowledge that will be generated as the project proceeds through the first and later stages should demonstrate emergent national capabilities in space technologies which are credible and which underpin a more active role by Australia in space in future.

By building the capacity for the country that SCRAMSPACE will generate, and by demonstrating credibility to the international community, the project will contribute substantial "skin in the game" for Australia to access space technology and infrastructure through collaborative arrangements between Australian and overseas governments, research organisations and companies. This will permit an appropriate level of self-reliance within the context of a heavily globalised and highly integrated market to be established and sustained.

*Professor Russell Boyce, DSTO Chair of Hypersonics, University of Queensland*

# Our research knows no boundaries.

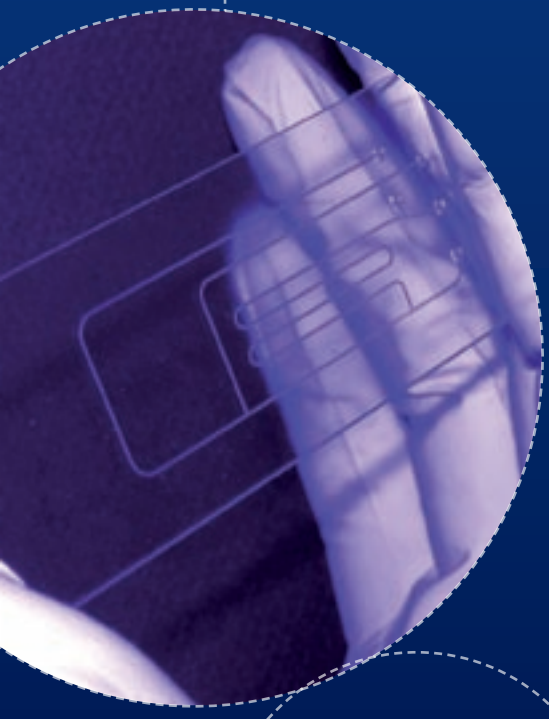
The University of South Australia (UniSA) is engaged in over 500 international collaborations across 45 countries, including 22 European countries. These are delivering a new era of research outcomes with international applicability and relevance across a range of areas including materials science and minerals processing, wireless communications, social sustainability, health and biomedical sciences, marketing science, sustainable systems and technologies, defence and complex systems, engineering and advanced manufacturing.

UniSA's Ian Wark Research Institute, led by Clunies Ross Lifetime Contribution Award winner Laureate Professor John Ralston AO FAA FTSE, has formal partnerships and agreements with institutions across 11 countries. Through a strong collaboration with the Max-Planck Institute for Metals Research (Germany) and the University of Tokyo (Japan) in the breakthrough area of microfluidics, advanced 'lab on a chip' technology has been developed. Just as microelectronics revolutionised the electronics industry, our breakthrough area of microfluidics holds the same promise for many process industries, with potential benefits including faster processing, smaller processing plants, and greater environmental and process control.

Professor John Lynch at UniSA's Sansom Institute for Health Research also has wide ranging research collaborations in Brazil, Canada, Denmark, Korea, Sweden, the UK and the US. Professor Lynch is an NHMRC Australia Fellow, and his collaborative research achievements with Bristol University in population health, particularly in the area of child development, have direct impact on practice in Australia and the UK, and long-term benefits for health planning internationally.

Great research outcomes like these can only happen when gifted minds from around the world have the opportunity to work with one another, exchange ideas and share a common goal. That's why UniSA is fast earning a reputation for its outstanding collaborative achievements, giving researchers the chance to make a real difference to the world we live in.

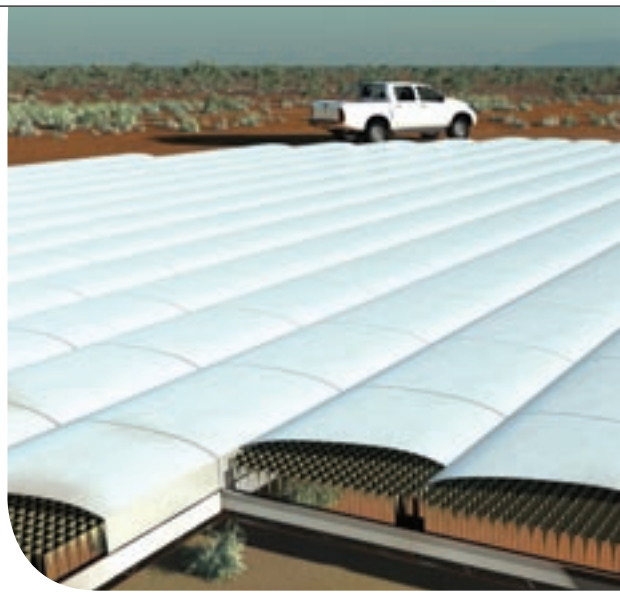
For more information about research at UniSA visit **unisa.edu.au/research**



***In the minerals processing industry, 'lab on a chip' technology has been developed to enhance solvent extraction selectivity and increase transfer rates by factors of 100 to 1,000.***

University of South Australia

# ICRAR research tunes in to the early universe



"Right now we are on the threshold of the greatest step ever taken on our cosmic journey of discovery"

International Centre for Radio Astronomy Research

A 'dish' antenna. Part of the Australian SKA Pathfinder operated by the CSIRO. *Photography by Paul Bourke and Jonathan Knispel. Supported by WASP (UWA), iVEC, ICRAR, and CSIRO.*

Through technology and human endeavour science and engineering have pushed back the frontiers of understanding, answering questions and asking many more. Using modern instruments to look beyond the spectrum of visible light we are now able to see the Universe in its entirety. Through the emerging science of radio astronomy we can detect the faintest whispers from the depths of space and beginning of time.

Right now we are on the threshold of the greatest step ever taken on our cosmic journey of discovery. The design and construction of the Square Kilometre Array (SKA) radio telescope will create a single scientific machine capable of studying the first objects to shine in the Universe, the beginning of the cosmic avalanche of growth that resulted in mankind some 13 billion years later.

The SKA will survey the sky 10,000 times faster than any other radio telescope. Both the Australian Decadal Plan for Astronomy (2005-2015) and the European Strategy Forum on Research Infrastructure (ESFRI 2008) have identified this instrument as a critical facility for international research in astronomy and astrophysics in the 21st century.

> "the SKA will survey the sky 10,000 times faster, than any other radio telescope…"

## ICRAR

In Perth, Western Australia, researchers from the International Centre for Radio Astronomy Research (ICRAR) are playing an important role in the design and ultimate success of the SKA. By working with international colleagues in fields such as galaxy formation and evolution, high angular resolution astronomy, high time resolution astronomy and advanced antenna engineering, ICRAR is engaging the global communities of science and industry to deliver the best possible SKA.

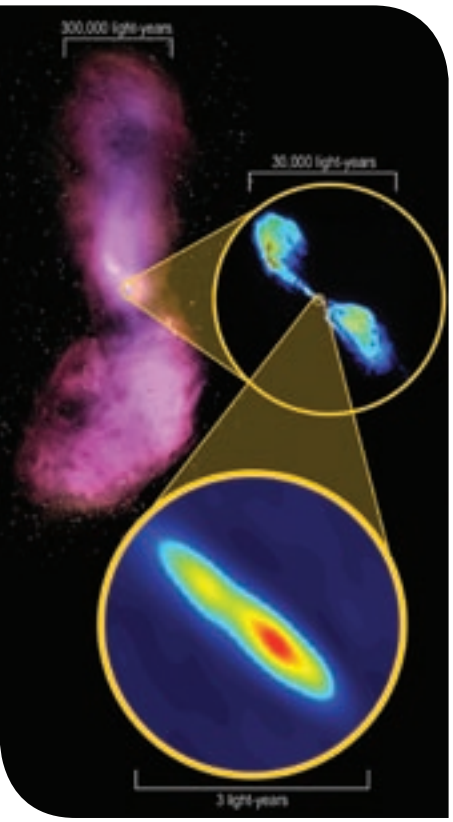
## Aperture Arrays for the SKA

Collaborating with researchers from nine EU nations, ICRAR scientists and engineers are making a significant contribution to the SKA "Aperture Array Verification Programme", a major component of the EU Framework Program 7-funded PrepSKA design study. Based on pioneering work carried out in Europe, this project centres on the design and prototyping of all-electronic "aperture array" receptors for the detection of radio wavelengths in the 70MHz to 1400MHz range. The development of large collectors composed of many small, low cost antenna elements is pivotal to the design and scientific performance of the SKA.

## Very Long Baseline Interferometry (VLBI)

Recently, six radio telescopes situated in Australia and New Zealand "joined forces" to observe the centre of Centaurus A, a galaxy located more than 14 million light-years from Earth. Capturing images 10 times more detailed than those of the Hubble Space Telescope, imaging this object at this level of detail is like photographing a pinhead from 20km away.

A computer generated image of an Aperture Array antenna. *Photo by: Swinburne Astronomy Productions and the SKA Program Development Office.*




ABOVE: Zooming in on galaxy Centaurus A. *Photo by: Whole galaxy: I. Feain, T. Cornwell & R. Ekers (CSIRO/ATNF); ATCA northern middle lobe pointing courtesy R. Morganti (ASTRON); Parkes data courtesy N. Junkes (MPIfR). Inner radio lobes: NRAO/AUI/NSF. Core: S. Tingay (ICRAR)/ICRAR, CSIRO and AUT*

RIGHT: A volume-rendered visualisation of expanding supernova remnant SN1987A, showing the expanding shock interacting with the pre-supernova environment. *Photo by: Simulation by Toby Potter, ICRAR and rendering by Dane Kleiner, Monash University.*

For these observations, ICRAR provided the data processing facilities and image processing expertise required to process the raw data and image this distant object. ICRAR possesses the only such facility in the Southern Hemisphere and the ICRAR VLBI team is considered an international leader in VLBI science and technology.

> …this level of detail is like photographing a pinhead from 20km away

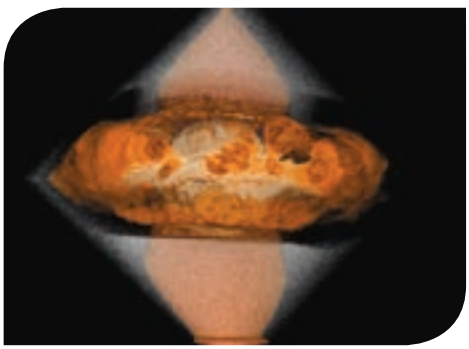
## High Performance Computing

Collecting extraordinary amounts of information with the SKA from distant parts of the Universe brings the monumental challenge of analysing and storing more data in one day than the global population currently produces in a year. At its heart, the SKA will have an ICT engine. The design and prototyping of these data intensive systems will be integral to the operation of the telescope and the discoveries that will flow from the data.

Data intensive research and the design of high performance systems and algorithms for radio astronomy is a major theme for ICRAR. Together with researchers from Europe, North America and India and industry leaders such as IBM, ICRAR is contributing manpower to the PrepSKA design study of the data flow, processing and storage system for the SKA.

## Global Collaboration

While the processing and storage of scientific results from the SKA and other large astronomical facilities is an ICT challenge of global importance, the delivery and exploration of this data is an even more pressing challenge. How do we compare results from different facilities? How do we launch new and complex inquiries on computing and storage facilities distributed around the world?



Tackling these big questions is the International Virtual Observatory Alliance – a collection of more than 15 national "virtual observatory" projects from Europe, North America, Asia and Australia. Europe's premier ground-based astronomy facility, the European Southern Observatory (ESO) based in Munich, has been one of the international driving forces in this alliance. Having already made significant leaps forward in virtual observatory technologies and data systems, the ESO is now working closely with ICRAR researchers so that advancements feed directly into the systems design of the SKA.

Students experiencing a panorama of the remote Murchision Radio-astronomy Observatory located in Western Australia. *Photo by: Paul Ricketts, The Centre for Learning Technology, UWA*

## Education & Outreach

ICRAR is a joint venture between Curtin University and The University of Western Australia. ICRAR actively engages the local, national and international community with the aim of raising awareness of radio astronomy and the many non-astronomy benefits generated by this endeavour.

The Centre has a strong postgraduate teaching program at the Honours, Masters and PhD levels, with students and mentors coming from around the globe to work at ICRAR. National and international scholarships provide students from other universities with a pathway to work with ICRAR researchers and become involved in the science and engineering of radio astronomy.

For more information visit www.icrar.org or email info@icrar.org ■

# THE FUTURE OF Australian-European cooperation in health and medical research

Health and medical research is increasingly an international enterprise. As Australia's peak agency for support of medical and public health research and training, the National Health and Medical Research Council (NHMRC) plays a central role in encouraging and supporting international collaborative research activities.

In May 2010, NHMRC released its 2010–2012 Strategic Plan, which reaffirms our commitment to supporting collaborative research endeavours that provide opportunities for Australian researchers to work internationally on the challenges that are impacting health on a global scale.

As a rich country with outstanding researchers, we have a responsibility to contribute to international discovery research. International collaboration ensures that Australian health and medical research remains at the forefront of disease prevention and treatment. It enables Australian researchers to strengthen their individual efforts by providing them with access to methodologies, technologies, training and knowledge available in other countries.

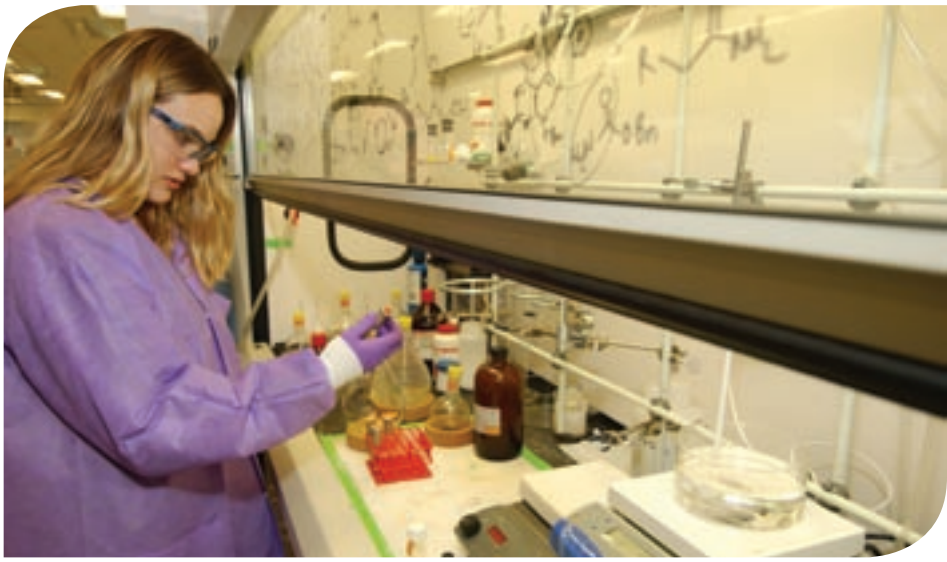
A measure of the success of Australian researchers is shown in the scale of ongoing international collaborations. NHMRC-funded researchers have reported that 65 per cent have worked in collaboration with international researchers, with 35 per cent of publications arising from NHMRC-supported research having at least one international author.

It is not surprising that Australian researchers are so successful in establishing international research collaborations. The quality of Australian health and medical researchers also measures extremely well against the international benchmarks. Independent bibliometric analysis of Australian health research publications showed, for all schemes, NHMRC publications achieved citations at a rate close to, or higher than 50 per cent above the world benchmark.

NHMRC's commitment to supporting initiatives that promote international research collaboration, particularly between Australia and Europe is demonstrated through the wide portfolio of international opportunities including:

- The NHMRC-European Union (EU) Collaborative Research Grants program – this program assists Australian researchers to participate in projects with international researchers that have been selected for funding under the Seventh Framework Programme of the European Community for Research and Technology Development (FP7). FP7 commenced in January 2007 and will fund projects over a five-year period. In 2009, the NHMRC committed A$4.1m in funding toward this program.
- The International Cancer Genome Consortium (ICGC) – in March 2009, NHMRC awarded A$27.5m over five years to support research into pancreatic and ovarian cancer. The ICGC is one of the most ambitious biomedical research

> "as a rich country with outstanding researchers, we have a responsibility to contribute to international discovery research"



A technician in a chemistry laboratory advances a chemical probe through analog synthesis.

**35%** of publications arising from NHMRC-supported research have at least one international author

Bacteria from human skin grown on agar in the laboratory.

efforts since the Human Genome Project. It spans 24 countries, and is expected to deliver significant benefits in detecting, preventing and treating cancer.

- Human Frontier Science Program (HFSP) – this program supports innovative, interdisciplinary and international basic research focused on the complex mechanisms of living organisms. It emphasises support for novel collaborations that bring together biologists with scientists from fields such as physics, mathematics, chemistry, computer science and engineering to focus on problems at the frontier of the life sciences. This highly successful program has supported approximately 5500 scientists from 65 countries, 16 of whom have gone on to win the Nobel Prize. Since 2004, NHMRC has committed over US$3.9m to HFSP. Over the same period, Australian researchers have been successful in securing 29 grants worth US$7.7m.
- L'Institut National de La Sante' et de La Recherche Medicale (INSERM) Exchange Fellowship – these aim to provide training in basic, clinical or public health research within the biomedical sciences in France for two years followed by two years in Australia. Since 2000, 11 Fellowships for training in France have been awarded at a total value of A$2.34m.

Funding international research can present many challenges, such as ensuring that the research is conducted ethically and with integrity. To ensure this occurs, funded Australian institutions must conduct research according to the principles outlined in the *Australian Code for the Responsible Conduct of Research 2007, the National Statement on Ethical Conduct in Human Research 2007 and the Australian Code of Practice for the Care and Use of Animals for Scientific Purposes 2004*.

This is an exciting period in health research. The promotion and support of international research collaborations is leading to advancements in our understanding across the four research pillars of biomedical, clinical, public health and health services research, and will ensure that we have a health system able to meet emerging health challenges, as well as the increased international expectations for the greater availability of effective new treatments.

*Professor Warwick Anderson*
*Chief Executive Officer*
*National Health and Medical Research Council*

www.nhmrc.gov.au

> "the promotion and support of international research collaborations is leading to advancements in our understanding across the four research pillars of biomedical, clinical, public health and health services research"

**65%**

**of NHMRC-funded researchers have worked in collaboration with international researchers**

A researcher uses a pipette to prepare DNA for sequencing.

UNIVERSITY OF CANBERRA
AUSTRALIA'S CAPITAL UNIVERSITY

# SERVING THE WORLD FROM AUSTRALIA'S CAPITAL

At the University of Canberra our researchers thrive on finding solutions to real world challenges: from combating disease to preserving cultural heritage; from exploring new ways of finding forensic evidence to mitigating the devastation of the environment.

In recent years, our research activity has experienced extremely strong growth, both in volume and significance.

- Work on an $11 million building to house the University's National Centre for Social and Economic Modelling (NATSEM) is nearly complete.
- The University has recently undergone a period of Academic Renewal designed to attract, develop, reward and retain the best academic staff from around the world.
- In 2008, our weighted publications ranking per academic jumped from 23rd to 10th in the country.
- Our research income per academic has almost doubled in the last two years.

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TO LEARN MORE ABOUT APPLIED RESEARCH AT THE UNIVERSITY OF CANBERRA, AUSTRALIA'S CAPITAL UNIVERSITY, VISIT:

## www.canberra.edu.au/research

# Swatting mosquito-borne viruses

When struck by the mosquito-borne dengue virus at 15 years of age, Suresh Mahalingam never thought he would grow up to lead the fight against these viruses as part of a small but determined team at the University of Canberra.

"I grew up in a little village in Malaysia and my house was next to a river," Professor Mahalingam, now a renowned virologist, said. "When I got sick my parents took me to hospital, but a friend from school died from the disease."

Diseases caused by mosquito-borne viruses are increasing at an alarming rate worldwide. In Australia, the Ross River virus affects 5000-8000 people each year. Globally, one of the worst offenders is the debilitating Chikungunya virus, which affects millions of people across Asia and Africa and has started to appear in Europe. This virus hasn't arrived in Australia, but according to Professor Mahalingam "it's only a matter of time."

Relief however could be in sight for those suffering from the arthritic pain and inflammation caused by these viral infections. Professor Mahalingam is soon to start clinical trials for a drug that could help alleviate these symptoms.

**5000-8000 people in Australia fall ill with the Ross River virus**

With funding of €50,000 and support from the Italian company Angelini Pharmaceuticals, he will conduct clinical trials of the drug Bindarit in two hospitals in western India. He estimates the drug could be in use within the next couple of years if the clinical trials show positive effects. Developing a new drug from scratch would have taken a decade or more.

Professor Mahalingam is also currently working together with European and Asian colleagues towards the development of new antiviral drugs and vaccines that not only could relieve the symptoms of the disease, but combat the actual Chikungunya virus.

Only a few months ago, he joined a group of researchers from Scotland, Germany, France, Estonia, Malaysia, Singapore and Australia to embark on a quest to do some brainstorming, pool their resources and work towards creating a drug or vaccine to control the mosquito-borne diseases that causes arthritis.

"There is great potential to design new antiviral strategies to control and eradicate mosquito-borne viruses, to find innovative ways for public health officials to fight outbreaks more effectively, to better understand the viral elements of the diseases and to predict where they might emerge next," Professor Mahalingam said. ■

## RESEARCH AT THE UNIVERSITY OF CANBERRA

Suresh Mahalingam is one of a growing number of researchers at the University of Canberra working at the forefront of applied research in a range of fields. Some of these areas are:

- Biomedical Sciences
- Forensics
- Ecology
- Information Sciences
- Software Engineering
- Sports
- Heritage Conservation
- Social and Economic Modelling
- Mathematics & Statistics
- Business & Government and
- National Security

To learn more about research at the University of Canberra, Australia's Capital University, visit: www.canberra.edu.au/research

# WORLD-CLASS
## research for the real world

Researchers and students are constantly generating and testing new ideas and technology in the Queensland University of Technology's real-world laboratories throughout south-east Queensland.

QUT's dedication to the integration of research in science, technology, engineering and mathematics (STEM) sees the university openly engage with stakeholder communities so they contribute to the development of leading-edge technologies that will take us into the future.

The Institute of Health and Biomedical Innovation (IHBI), located on the innovative and specifically developed Kelvin Grove Urban Village campus, is QUT's largest institute and a nexus for some 600 STEM researchers. In a building designed to enhance cross disciplinary interaction, scientists, biomedical engineers, practising surgeons, biochemists, physicists, biologists, biostatisticians, mathematicians and laboratory technicians meet and collaborate.

Their research domains focus on the following areas:

- Burns, fractures, healing, surgery cancer, disease and infection
- Dementia, obesity diabetes, schizophrenia, addiction, melanoma, medical treatment and palliative care
- Ageing workforce, work and sport injuries, and road safety
- Arthritis, osteoarthritis, back pain, spinal injuries, orthopaedics, and trauma
- Hunger, malnutrition, disease, poverty and vitamin deficiencies
- Myopia, eye injury, cataracts, glaucoma, visual rehabilitation and accident prevention.

A national research project spearheaded by QUT is aiming to revolutionise airport security across the country.

FAR LEFT: Professor Peter Grace is monitoring carbon dioxide and greenhouse gas emissions using a newly built mini flux tower and automated greenhouse gas monitoring equipment at QUT's Samford Ecological Research Facility.

LEFT: Biochemist, inventor and tissue engineer, Professor Zee Upton is breaking new ground with her tissue repair and wound healing research.

IHBI is a career-building powerhouse for researchers with QUT's early career academic program, designed to nurture them into a successful academic career by providing a comprehensive suite of skills and ready opportunities to tap into IHBI's strong networks and collaborative relationships.

IHBI's tissue repair and regeneration research program is an example of the opportunities that exist. Professor Zee Upton heads this research team whose program focuses on skin and wound repair, and the regeneration of load-bearing tissue. Here, researchers in cell and molecular biology, bioactive and biomimetic materials, biomechanics, tissue mechanics, diagnostic/monitoring image and signal processing, and mathematical

## SCIENCE AND TECHNOLOGY PRECINCT UNDERWAY

QUT's commitment to producing world-class STEM researchers will see the opening of a $230m dedicated Science and Technology Precinct at the Garden's Point campus in 2012. The precinct will interweave the teaching and research of STEM disciplines in a world-leading research model to form a dynamic community hub focused on addressing solutions for climate change, sustainable infrastructure, food, energy and water security. The precinct's research will be supported by real-world laboratories and pilot plants at satellite sites in Queensland.

QUT has a number of well-established research streams located in real-world environments and include:

- Aeronautics – Professor Rodney Walker is director of the Australian Research Centre for Aerospace Automation hosted by QUT at the Da Vinci Precinct at Brisbane Airport. His research includes general aviation automation, small satellite avionics and sensors, satellite navigation and civil application of UAVs.
- Information Systems – Professor Michael Rosemann is chief investigator on a number of applied research projects in business services management. He co-leads the Business Process Management Group, which carries out research in many different aspects of BPM.
- The Airports of the Future – QUT, in conjunction with Brisbane Airport Corporation and 33 other partners, is leading a multi-disciplinary international collaborative research project exploring the complexity of modern airports and addressing conflicts between aviation security and the passenger experience.

QUT's Science and Technology Precinct, opening in 2012, will be a dynamic hub for STEM research.

- Sustainable resources – Professor Peter Grace heads research at the Institute for Sustainable Resources, which studies the impact that increased population is having on our fauna, greenhouse gases and waterways for the national Terrestrial Ecosystem Research Network (TERN). This research is based at QUT's 51-hectare bushland property, the Samford Ecological Research Facility north of Brisbane.

**Helpful links:**
qut.edu.au | qut.edu.au/scitechprecinct | ihbi.qut.edu.au

modelling work with clinicians in orthopaedics, burns and wound repair to apply their research results to benefit the community.

Bringing the research to the real world, biotechnology company Tissue Therapies (an Australian Stock Exchange-listed company) was established to commercialise this research. A key outcome is VitroGro®, a novel growth factor complex that enhances cell proliferation and migration in a range of cell types.

Cardiff University's Professor Keith Harding is medical advisor to Tissue Therapies and has collaborated with IHBI and Tissue Therapies for clinical trials of VitroGro®. Professor Upton expects VitroGro® to be available to the public by 2011 as an ulcer spray and bioactive bandage for chronic wounds such as diabetic ulcers and injuries such as burns.

Allied to this line of research is the Australian Government-funded Wound Management Innovation Cooperative Research Centre (CRC) based at QUT and led by Professor Upton and Professor Helen Edwards of QUT's School of Nursing. This CRC is the world's first interdisciplinary national wound research initiative, with funding of A$28m to focus on interdisciplinary research on healing of chronic wounds. It combines QUT expertise in life and chemical sciences, nursing, business and IT to find cost-effective ways to improve healing and lessen the estimated $2.6 billion cost of this largely hidden problem.

Mathematicians have a key role in these projects with several PhD students developing mathematical models to aid understanding of cell dynamics in the healing process or used to design individual treatments for wound patients. Mathematicians Dr Jennifer Flegg and Professor Emeritus Sean McElwain collaborate with Professor Helen Byrne from University of Nottingham on mathematical modelling to understand how hyperbaric oxygen can assist the healing of chronic wounds.

Biomedical engineering is a stand-out research strength of QUT. IHBI's Medical Device Domain draws together STEM researchers from many fields to work with practising surgeons to design artificial limbs, organs, treatments and devices for:

- arthritis, osteoarthritis, and other musculoskeletal conditions;
- spinal deformity, back pain, spinal injuries and diseases, and;
- fractures and other trauma injuries.

The Domain's unique combination of collaborating investigators provides a "complete picture" approach to solving problems. Key solutions involve joint replacement and fixation of implants, bone substitutes, biological interfaces, healing of fractures, aid devices and trauma management. IHBI biomedical engineers have established research nodes at The Prince Charles, Princess Alexandra, and Mater Children's hospitals as well as with industry end-users. QUT's Medical Engineering Research Facility (MERF) at The Prince Charles Hospital provides a comprehensive suite of facilities for skills training of surgeons and allied health workers. ■

# Achieve

international research excellence.

Join us.

Professor Mike Tobar, whose work has led to the development of the sapphire oscillator, the most accurate time measurement device in the world.

Professor Kadambot Siddique, who is working to promote and disseminate 'best bet' crop varieties and farming systems in Iraq, and 'Seeds for Life' in conflict-ravaged East Timor.

Professor Barry Marshall, the brilliant Nobel Laureate who drank a harmful culture of bacteria to prove that they, not stress, cause stomach ulcers and gastric cancer.



If you want to achieve world-class results and work with researchers who are already doing just that, we invite you to collaborate with The University of Western Australia. Our focus on research of international quality and the fostering of an outstanding research culture have positioned UWA as one of the leading universities in Australia and in the top 150 in the world. We continue to attract award-winning teachers, researchers and students from around the world whose individual reputations have helped to build ours. **Explore the research opportunities at www.research.uwa.edu.au**

THE UNIVERSITY OF WESTERN AUSTRALIA

*Achieve International Excellence*

# Neuroscience at UWA

Understanding how blind lizards can have their sight restored is contributing to one of medical science's biggest challenges: getting neurotrauma victims up and walking again.

University of Western Australia's (UWA) neuroscience research group, which supports neuroscience undergraduate and postgraduate teaching, is working on regenerating human nerve fibres.

Neuroscience research spans three faculties and includes academics from the disciplines of medicine, psychology, psychiatry, anatomy, animal biology, physiology and biochemistry. Neuroscience research at UWA and affiliated institutions includes:

- developmental neurobiology, examining how different genes control the differentiation and migration and survival of cells in the immature nervous system;
- auditory physiology and processing of auditory information in the cochlea and brainstem;
- temperature regulation of the body and brain;
- colour vision and face perception and many aspects of cognitive processing;
- multiple sclerosis and motor neurone disease, and more neurotrauma work in visual system, brainstem, cerebellum, and spinal cord;
- studies using gene therapy, new molecules and transplants to try to replace injured cells and induce regeneration.

Our lead researchers in this area each have several EU linkages and collaborative partners.

## Professor Shaun Collin

***School of Animal Biology and UWA Oceans Institute***

Professor Collin's research involves investigating the neural basis of behaviour in a range of organisms, and how sensory signals are detected and used in feeding, reproduction, migration, social interactions and predation. Recently funded projects include using sensory indicators to improve the diet and growth of finfish for the aquaculture industry, investigating how sharks use a well-developed battery of senses to sample their environment and tracing the evolution of the vertebrate eye.

## Professor Sarah Dunlop

***School of Animal Biology***

Professor Dunlop's research examines the potential for nervous system repair after traumatic injury. The work spans basic science to translational research involving randomised controlled trials of novel exercise regimes for spinal cord injured patients across all eight spinal units in Australia and New Zealand

## Winthrop Professor Alan Harvey

***School of Anatomy and Human Biology***

Professor Harvey's laboratory research focuses on injuries and degeneration of the nervous system and neurotherapy. The work centres primarily on the retina and central visual pathways. Professor Harvey is pioneering a range of experimental approaches that combine elements of gene therapy, treatments using drugs and cell transplantation to enhance neuronal survival and the regeneration of axons after brain injury. He also has a research interest in the pathology of Alzheimers Disease.

Research of international quality and the fostering of an outstanding research culture have positioned UWA as one of the best universities in Australia and in the top 150 in the world. The 2009 Shanghai Jiao Tong University, Institute of Higher Education ranking of world universities lists, by field, UWA's Life and Agricultural Sciences as ranked 44th in the world.

Priority research areas:

- plants, animals, agriculture and environment (including management of natural and agricultural systems)
- exploration, production and utilisation of minerals, oil and gas
- fundamental bio-medical and translational approaches to health
- indigenous knowledge
- bio-engineering and bio-imaging
- neuroscience (including psychology).

Emerging and seed priorities in the sciences include:

- metrology and measurement
- radio astronomy
- green chemistry
- marine and ocean sciences.

Many of our staff already collaborate with EU institutions and we welcome the opportunity to extend this collaboration. Further information on UWA's research may be found at **www.research.uwa.edu.au**

# EXCELLING in the study of plant energy systems

Close up of an arabidopsis flower.

Plants harvest energy from sunlight, huge amounts of energy that ultimately feed, clothe and fuel the world. Tapping into this potential is what drives the *ARC Centre of Excellence* for Plant Energy Biology (PEB).

Australian Research Council (ARC) "Centres of Excellence" are Australian-based centres of collaboration, bringing together expertise, technology and world-class researchers to address important scientific questions while training the next generation of scientists.

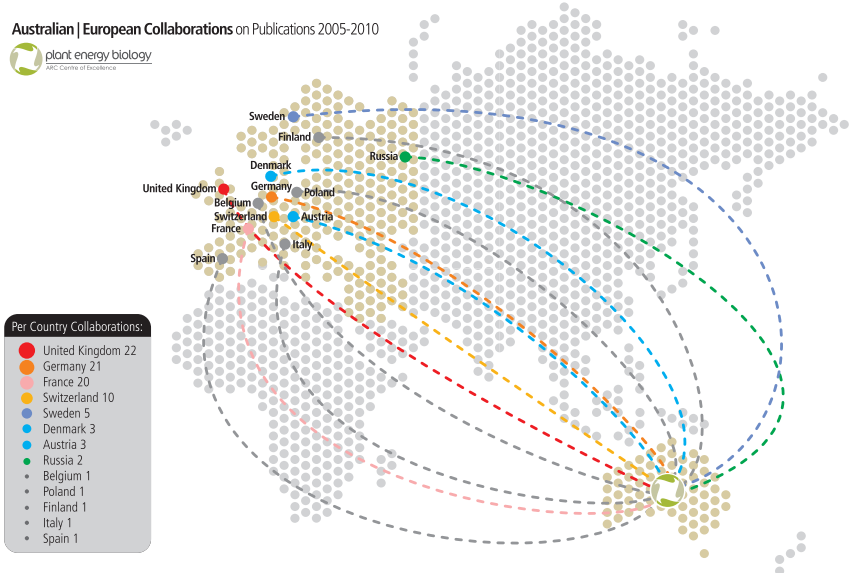
Over 70 researchers work on the centre's key interests, which primarily concentrate on how energy is harvested from sunlight and transformed into chemical energy in plant cells. The "energy compartments" inside a cell – chloroplasts, mitochondria and peroxisomes – are the focus of studies which aim to answer questions like: how are these energy organelles made at a molecular level? How do they produce and exchange chemical energy? How do they "talk" to each other to coordinate these processes?

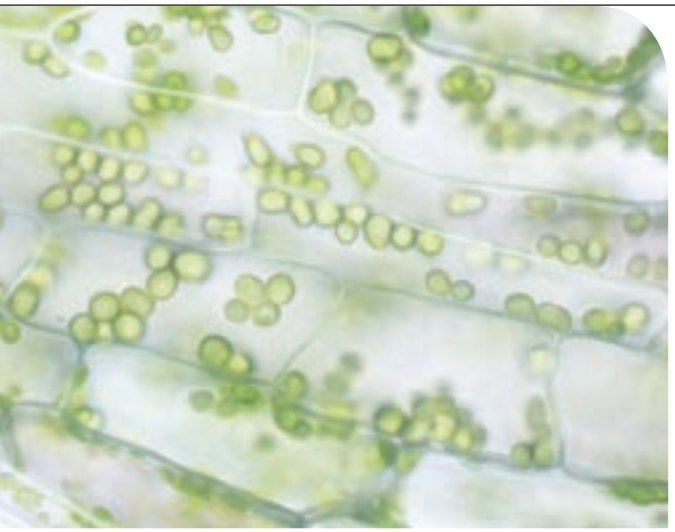
Most of PEB's research is fundamental plant science focusing on model plants such as *Arabidopsis* and rice, which is both benefitting from and contributing to collaborative international efforts to understand the basic processes underpinning plant growth. PEB has strong links to plant research centres in Europe, the USA, China and Japan.

The European research project (AGRON-OMICS – Arabidopsis GROwth Network integrating OMICS technologies) is a great example of how European-Australian collaboration benefits all parties involved. The *Arabidopsis* leaf is the focus of 14 European laboratories funded from an EU Framework grant, plus PEB, which is funded by the Australian government (DIISR International Science Linkages grant). The collaborative project is investigating the fascinating molecular processes driving growth in leaf cells and looking at how these processes affect the way the plant develops. European researchers benefit from PEB's specialist analysis of organelle biology and energy metabolism and PEB gains access to various techniques and datasets not available within the Centre (contact Ian Small at iansmall@cyllene.uwa.edu.au).

> "all teams gain massive benefits by avoiding long and expensive delays while new approaches are developed in-house and personnel are trained to use them, keeping our research at the cutting-edge"

PEB Director, Professor Ian Small explains the importance of collaboration to the organisation: "By sharing the technology platforms in this way, all teams gain massive benefits by avoiding long and expensive delays while new approaches are developed in-house and personnel are trained to use them, keeping our research at the cutting-edge."





TOP: Chloroplasts are cellular organelles in plants where photosynthesis occurs.

ABOVE: Arabidopsis seedling

Other major European collaborations for PEB also include Umeå Plant Science Centre (UPSC) in Sweden and the Max Planck Institute of Molecular Plant Physiology in Golm, Germany.

The benefit of fundamental research such as the AGRON-OMICS project can be hard to fathom for the general public. What becomes apparent after talking to these researchers is that they strive to understand the inner workings of plants in order to provide novel genetic routes to improve essential plant traits such as growth, yield and stress resistance. This is the knowledge that will drive our ability to meet food production requirements on a planet faced with climate change and rapidly expanding populations.

As well as this fundamental research, PEB is also actively undertaking a variety of projects with direct links to the agricultural needs of the community. It's exciting to learn that the payoffs of collaboration are already being seen in this area. In 2009, a PEB/GRDC/CSIRO joint venture identified a plant protein which when altered significantly increases tolerance to drought stress. This knowledge is now being applied to wheat improvement with the hopes of significantly increasing wheat yields during drought conditions (contact Barry Pogson at barry.pogson@anu.edu.au).

And it's not just wheat that's being looked over with a fine-toothed comb. A recent collaborative project involving PEB, the University of Western Australia and grape growers in Carnarvon, a sub-tropical region of Western Australia, is working on solving problems with fruiting consistency due to a lack of temperate "seasons". The problem for the plants is that they lack the environmental cues to induce dormancy and flowering. This ongoing research could have significant impact for grape and fruit growing regions in similar climates such as Portugal, Spain and Italy (contact Jim Whelan at seamus@cyllene.uwa.edu.au).

The improved use of fertilisers is important for agricultural regions worldwide and is a key research area for PEB. Several Australian universities, including the PEB group, are applying their expertise in molecular profiling to a suite of crop plants from US biotechnology company, Arcadia Biosciences Inc. The aim is to try to uncover the molecular basis of plants that show increased nitrogen use efficiency. Fundamental metabolic changes in these plants maintain grain yields with less applied nitrogen fertilizer, reducing costs, reducing energy usage in fertiliser production and decreasing the leaching of unused nitrogen from agricultural soils into natural ecosystems, rivers and oceans.

Further recent funding to the centre will also allow early career researchers to study phosphate uptake by crop plants. The aim is to drastically reduce the use of phosphate fertilisers by breeding crop plants far more efficient at drawing out the many billions of dollars worth of currently unusable phosphate fertiliser locked inside the world's soils (contact Jim Whelan at seamus@cyllene.uwa.edu.au or Harvey Millar at hmillar@cyllene.uwa.edu.au).

This kind of exciting research could have enormous impacts on the community, making science communication an increasingly important part of scientific research. The enthusiasm for outreach activities comes from the ability to capture the public's attention and create a dialogue about science and how the community benefits from the public funding that goes into research. PEB runs diverse outreach activities spanning workshops, experiments, exhibitions and public talks and is keen to collaborate with like-minded research facilities (contact Alice Trend at atrend@uwa.edu.au).

Further projects under this diverse portfolio can be viewed at www.plantenergy.uwa.edu.au

## *ARC CENTRE OF EXCELLENCE* FOR PLANT ENERGY BIOLOGY (PEB)

**PEB was established in 2005 with an ARC grant and matching contributions from the three partner universities (UWA, ANU and Flinders University). In five years of operation PEB has achieved considerable scientific success in understanding gene expression in energy organelles, plant energy metabolism and responses to environmental stress.**

- **Centre authors have contributed to over 150 publications, including key breakthroughs published in Science, Nature, Cell, Proceedings of the National Academy of Sciences and The Plant Cell.**
- **30 per cent of Australian papers published in top-ranked plant science journals in 2009 included authors from PEB.**

# EMBL down under

In March 2008 Australia accepted an invitation to partner with Europe's pre-eminent research institute, the European Molecular Biology Laboratory (EMBL). This partnership saw Australia granted Associate Member status (the first ever offered) for a seven-year period and EMBL Australia was born.

"The EMBL model has been such a success in Europe, creating a dynamic scientific environment, with fixed-term contracts partnered with a generous package so that young scientists have solid support to really get their careers established," says developmental geneticist Professor Nadia Rosenthal, Director of EMBL and founding director of the Australian Regenerative Medicine Institute (ARMI).

Rosenthal emphasises that the EMBL is crucial to retaining talented young scientists in Australia and encouraging them to take risks at a time in their career when they are at their most productive.

"It also means that all these well-trained scientists in various disciplines have the opportunity to take on leadership roles here, rather than going overseas to get those opportunities. Australia needs its own ready source of accomplished scientists. To keep them here, it was absolutely critical to provide a concentration of research into dedicated and excellent institutes."

At the same time, EMBL Australia offers an international PhD program for Australian students to study at one of EMBL's five European sites. A PhD would then be jointly awarded by the student's Australian university and the EMBL.

Australian science benefits from the EMBL membership through access to state-of-the-art infrastructure and technologies, expertise and networks in Europe, which in turn will provide new opportunities for Australian researchers to forge collaborations with European researchers and institutions. However,

EMBL Australia Director Professor Nadia Rosenthal identified areas where EMBL could benefit enormously from a close association with Australian science.

the complementary nature of Australia's strengths makes EMBL Australia of great benefit to Europe. This was no accident. Rosenthal, one of the key architects of EMBL Australia, specifically identified areas where EMBL could benefit enormously from a close association with Australian science.

"The environment here for doing stem cell research puts Australia in a very powerful position right now – it's an area that Europe doesn't compete in," she says.

Rosenthal also points to Australia's biodiversity as a major strength, as well as areas such as regenerative medicine, chemical biology, comparative genetics, bioinformatics and genetic epidemiology. Strengths such as these will form the basis of the Partner Laboratory Network, which aims to make Australia a complementary international research hub that not only draws upon Australia's talented scientists, but also brings in overseas members attracted by the unique strengths of Australian life sciences.

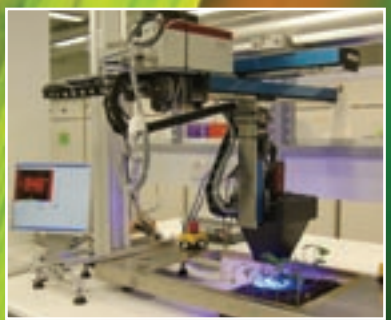
The Partner Laboratory Network will consist of EMBL Australia research groups at the universities of Sydney, Queensland and Western Australia, with the first EMBL Australia Partner

"the aim is to make Australia a complementary international research hub that not only draws upon Australia's talented scientists, but also brings in overseas members attracted by the unique strengths of Australian life sciences"

Laboratory Network groups located at the Australian Regenerative Medicine Institute (ARMI), based at Monash University. These four centres will eventually support 18 group leaders with enough funding to run a small lab for five years. This network will bring together research laboratories, core facilities and translational capabilities drawn from existing universities, medical research institutes and the CSIRO.

"In what is perhaps a first for life sciences here, Australia's research community will have a way to tap into critical mass within Europe," Rosenthal says. "At the same time, we expect that the EMBL training model, which is seen as world's best practice, will develop a culture that will foster free-thinking talent in Australia."

www.emblaustralia.org



Australian
Plant Phenomics Facility

**State-of-the-art phenotyping tools to help researchers understand and relate the performance of plants to their genetic make-up.**

The Australian Plant Phenomics Facility (APPF) is a cross-institutional facility, which involves two quite different, but highly complementary research centres - The Plant Accelerator™ and the High Resolution Plant Phenomics Facility (HRPPC).

The two nodes provide state-of-the-art capabilities for plant phenotyping (offering controlled environments, field-based plant growth monitoring using high throughput robotics, automated imaging and computing technologies), integrated with the ongoing adaptation and application of emerging phenomics measurement technologies.

Our team of experts provides services to national and international academic and commercial plant scientists.

### The Plant Accelerator™

The Plant Accelerator™ (APPF headquarters) at The University of Adelaide offers:

Automated high throughput plant imaging to

- Accelerate research
- Accelerate crop improvement

### The HRPPC

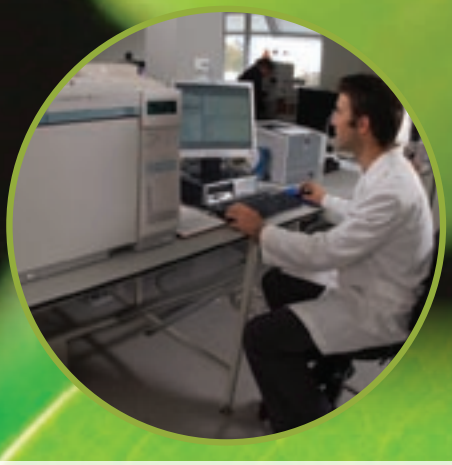
The HRPPC at CSIRO Plant Industry and the ANU in Canberra offers:

High resolution plant phenotyping from growth cabinet to the field

- Stress tolerance
- Yield potential
- Gene function improvement

# Australian Plant Phenomics Facility

www.plantphenomics.org.au



**The ARC Centre of Excellence in Plant Energy Biology (PEB)** is always looking for new collaborators and is interested in expanding our Centre with scientific talent.

What are we looking for exactly?

Research Fellows to lead exciting new projects, post-doctoral fellows to join groups doing cutting-edge research in plant biology and PhD students to be trained as the next generation of highly-skilled plant scientists.

PEB's technology platforms include the latest facilities for proteomics, transcriptomics, metabolomics, bioinformatics and plant phenotyping. The Centre also has close ties to the High-Resolution Plant Phenotyping Centre, one of the most highly advanced public facilities for studying plant growth anywhere in the world.

If you are interested in any form of collaboration with PEB, or working or studying with us please check out our website: **http://www.plantenergy.uwa.edu.au/** or contact: **ian.small@uwa.edu.au**

plant energy biology
ARC Centre of Excellence

# SeagrassTIME

A collaboration between Edith Cowan University (ECU) and the Leibniz Institute for Marine Sciences in Germany is providing new insights in the susceptibility of valuable marine ecosystems to nutrient pollution.

The collaboration brings together highly experienced seagrass researchers from Australia and Europe, with knowledge of a wide range of different types of seagrass ecosystems. By undertaking the research in both Australian and Baltic Sea seagrass ecosystems, which differ in many fundamental respects, the project is able to test more generalised concepts than has previously occurred.

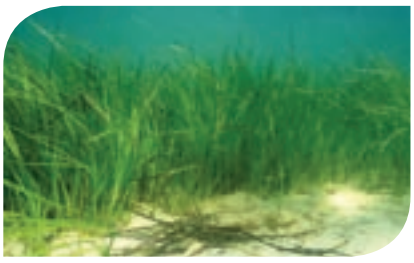
Britta Munkes and Paul Lavery have been funded through the European Union's Marie Curie Fellowship Scheme to investigate factors that may mitigate against harmful effects of nutrient pollution in seagrass ecosystems.

Eutrophication is one of the most significant causes of coastal habitat loss worldwide and contributes to the alarmingly high loss of seagrass habitats, which is about 110 square kilometres each year. The implications of this loss are profound given the range of ecosystem services that seagrass meadows provide, including their importance for coastal fisheries.

Until recently, it was generally accepted that, along with light, nutrient availability was the key control on aquatic primary productivity and that nutrient additions promoted algal smothering of seagrasses. However, there is growing evidence where seagrass ecosystems have intact foodwebs, the effects of nutrient enrichment on algal growth and seagrass decline are less apparent as grazer communities can control algal growth.

The project SeagrassTIME aims to determine the importance of marine grazers in stabilizing ecosystems against the effects of eutrophication. The project investigates the capacity of different grazers to control the effects of nutrient additions to seagrass ecosystems, and the importance of the composition of those grazers' assemblages. Complementary funding through the Australian Government and CSIRO is allowing the investigators to also examine the role of hydrodynamic process in controlling the effects of nutrient enrichment on seagrass ecosystems. Observations and previous research indicate that the movement of seagrass leaves in response to waves prevents the overgrowth of seagrass leaves by algae.

However, leaf movement may also prevent grazers attaching to leaves and grazing down algal growth. Through a series of field experiments in Germany and Australia, this research is disentangling how these different processes interact to control the effects of eutrophication in seagrass systems. Through this, we will be better placed to assess the risk that nutrient pollution poses for seagrass habitats. ■



Seagrass AS7: shows a Zostera marina seagrass meadow. This is the typical seagrass from the German coast of the Baltic Sea. It does not occur in WA.

A diver in a Posidonia australis meadow sets up the experimental enclosures. These used blue barrels that had large windows covered by mesh as an experimental cage.

Drilling a bore hole to measure soil water distribution and groundwater levels on the Gnangara aquifer.

## UNDERSTANDING GROUNDWATER

The Gnangara Groundwater Mound, is an important source of drinking water for metropolitan Perth. Overlying this shallow aquifer is Banksia woodland vegetation, which can develop a dependence on groundwater. Aquifers are a particularly important water source for vegetation in Mediterranean climates, where it has been shown that phreatophytes (plants that access groundwater) can survive summer drought by having extensive water acquiring root systems.

Any changes in groundwater availability through abstraction, climate change or changes in surrounding land-use have consequences for the overlying groundwater-dependent vegetation. In order to identify tolerable changes in water availability that allow for the maintenance of phreatophytic vegetation, we need to unravel the mechanisms behind vegetation response to alterations in groundwater regimes.

Research is currently being conducted by Ray Froend and Will Stock as part of an ARC linkage grant with the Water Corporation. This research is investigating how plants respond to changes in groundwater availability, especially the behaviour and dynamics of roots at various levels in the soil profile. In addition to field studies, a glasshouse study is investigating how plant roots grow in response to changing water tables. Knowledge of root growth rates is essential from a management perspective since we need to know the rate at which roots are able to follow a declining water table. The outcome of the project will influence decisions associated with the water management of the Gnangara Aquifer.

# AIMS: Australia's tropical marine research agency.

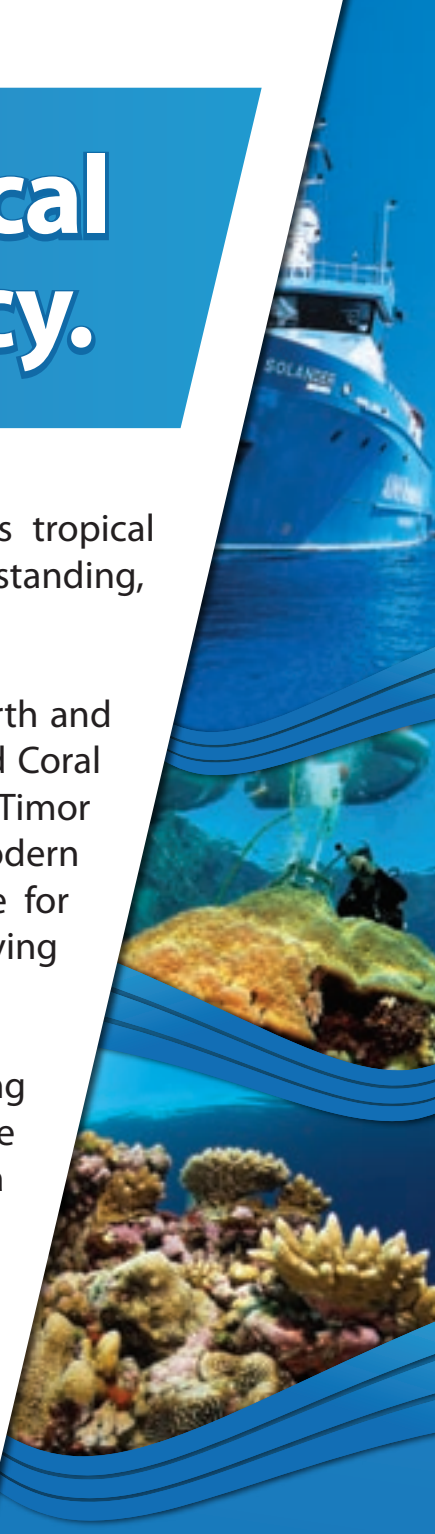
**The Australian Institute of Marine Science** (AIMS) researches tropical marine ecosystems through themes of discovery, process understanding, conservation, and sustainable use of living resources.

The Institute has 220 staff operating from bases in Townsville, Perth and Darwin, which provide access points to the Great Barrier Reef and Coral Sea, Torres Strait, Ningaloo Reef and the Kimberley coast, and the Timor and Arafura Seas. AIMS has world-class laboratory facilities, two modern research vessels, extensive technical support and is responsible for much of the infrastructure of Australia's Integrated Marine Observing System deployed in the tropics.

Facilities on AIMS sites in Darwin and Townsville are currently being enhanced through a capital funding contribution from the Australian Government. In Townsville, this will include a state-of-the-art ocean environment simulation facility located within an extensive seawater precinct, to support innovative research into coral spawning, water quality and climate change.

All of this infrastructure supports five multidisciplinary Research Teams that in 2009 published 125 peer-reviewed outputs covering biodiversity surveys and ecological/evolutionary processes; long-term monitoring and sustainable resource use; biogeochemical processes and ecosystem health; history and impacts of climate change and molecular and genetic mechanisms of marine symbioses.

The Institute has working relationships with more than 90 organisations across Australia and in 20 countries around the globe.



Australian Government

AUSTRALIAN INSTITUTE OF MARINE SCIENCE

**www.aims.gov.au**

# Leading the world in coral reef science

Chaetodon trifasciatus and Acropora municata. *Photo by Terry Hughes.*

Globally, the welfare of more than 200 million people is closely linked to the goods and services provided by coral reef biodiversity. In Australia alone, tourism and fisheries on the Great Barrier Reef contribute over A$6 billion annually to the nation's economy.

The ARC Centre of Excellence for Coral Reef Studies is a world leader in coral reef research, ranked #1 globally for outputs and citations in coral reef science. It is the world's largest provider of graduate training in coral reef science, currently supporting 165 graduate students.

In 2009, the ARC Centre's international collaborations and co-authorships included the *Resilience Alliance, the Stockholm Resilience Centre*, the *World Fish Center*, and 345 other institutions in 52 countries.

The Centre published 224 peer-reviewed articles in 2009. Among them is a provocative multinational study on planetary tipping points published in *Nature*, and a Policy Forum article in *Science* magazine on missing institutions for coping with trans-boundary issues such as climate change and oceanic fisheries. A new ISI Web of Science analysis of journal publications and citations identifies the ARC Centre as the premier climate change research institution in Australia.

In 2009, the ARC Centre's fieldwork was undertaken in 23 tropical countries, with a major ongoing focus in the Coral Triangle region to the north of Australia. The Centre expended over $3m to support fieldwork in the Philippines, Indonesia, Papua New Guinea and the Solomon Islands. The Centre's website features a new list of links to 134 of the Centre's recent publications undertaken within the Coral Triangle.

The ARC Centre is a major provider of expertise to governments and NGOs in many countries. For example, in 2009, Professors Malcolm McCulloch and Terry Hughes from the ARC Centre joined colleagues from National Academies of Australia and nine other countries to craft an Inter-Academy statement on ocean acidification. The statement, timed in advance of the Copenhagen United Nations Framework Convention on Climate Change (UNFCCC) negotiations, summarizes the current state of the science, and is aimed at policy-makers. In September, Terry Hughes delivered a plenary talk in Stockholm, at an international conference of environmental policy-makers, held under the auspices of the Swedish Presidency of the European Union. Currently, Professor Bob Pressey is developing a comprehensive guide to conservation planning for the *International Union for Conservation of Nature* (IUCN). "The motivation of this guide was to cut through the confusion produced by the many alternative approaches to conservation planning being developed and promoted with the aim of improving the effectiveness of planning worldwide," he says.

In 2012, the ARC Centre will host the 12th International Coral Reef Symposium in Australia, hosting approximately 2000 coral reef researchers from 80 countries.

www.coralcoe.org.au

ABOVE: Isabel Island, Solomon Islands. Solomon Islands is one of the countries of the Coral Triangle, where the Centre of Excellence undertakes field work. *Photo by Simon Foale.*

LEFT: Clown Fish pair. *Photo by Simon Foale.*

## ARC CENTRE OF EXCELLENCE FOR CORAL REEF STUDIES

**RESEARCH:** climate change, coral reef ecology, marine reserves, fisheries biology, genomics, conservation planning, social studies, governance and policy.

**PARTNERS:** James Cook University, Australian Institute of Marine Science, Australian National University, Great Barrier Reef Marine Park Authority, University of Queensland and the University of Western Australia. Collaborative links to 345 countries in 52 countries.

**OUTCOME AREAS:** environmental, economic, policy, governance.

# Investing in ideas

**Robust research is vital to understanding our world. It will help unlock the answers to the medical, environmental, economic and social challenges we will face in the future.**

**At Flinders University we are making a major investment in the next generation of young researchers, giving them the knowledge and skills to rise to those challenges**

## Supporting young researchers

Flinders has programs specifically designed to nurture and mentor young researchers, encouraging their growth and development, and turning ideas into outcomes.

The University recently recognised the outstanding results, and future potential, of nine young men and women with the Vice-Chancellor's inaugural Awards for Early Career Researchers in which cash rewards accompanied the accolades. They included medical scientist Dr Kathryn Burdon (pictured) who is researching the genetic causes of diabetes-related eye disease.

## Family Friendly Fellowships

It is a feature of active research and engagement with one's peers that young researchers travel to attend conferences and add to the pool of ideas, from which solutions can emerge.

Flinders University has introduced a bold new concept of Family Friendly Fellowships. These Fellowships allow staff who are carers to travel and alleviate the stress of conference participation on families by facilitating travel for partners and children or providing support for family members who remain at home while a carer is away.

The Fellowships will also facilitate re-entry to the workforce after parental leave.

## Harnessing new talent

More broadly, Flinders University continues to build on its excellent reputation for research with an accelerated employment program for emerging leaders in academia, supporting staff to become more research-active, expanding industry and academic relationships, and strengthening international research collaborations.

One example of this is the Strategic Professorships initiative being undertaken by Flinders, which is designed to sharpen the University's research profile by strengthening key activities in areas of particular focus.

A vibrant, supportive and sustaining culture is fundamental to successful research. With innovative programs that bring out the best in its young men and women, Flinders University is making the investment in ideas that will deliver dividends for society at large.

**www.flinders.edu.au**

Flinders UNIVERSITY

inspiring achievement

# Flinders Uni makes its mark with groundwater

Tapping groundwater.

The work of the National Centre for Groundwater Research and Training (NCGRT), based at Flinders University, South Australia, is putting Australian groundwater on the world map, according to a group of eminent, international water specialists.

The NCGRT was established in 2009 with a total of A$56m in cash and in-kind support from the Australian Government, Australian Research Council and 19 partners Australia-wide, including 11 other universities in addition to Flinders University (the administering organisation) plus eight industry and government agency organisations.

Mound springs in Central Australia.

In one of the largest, single recruiting drives for water professionals seen in Australia, the new Centre is filling more 170 positions over the next four years, with study and employment opportunities for Honours and PhD students, postdoctoral fellows, technical officers and research fellows.

NCGRT Director Professor Craig Simmons said the recruiting and training of the next generation of groundwater researchers and professionals is a vital element of the Centre's capacity building task.

"Over 400 expressions of interest were received for the first 40 or so positions that commenced this year with many of these from overseas," he said.

In February, Flinders hosted the inaugural, week-long meeting of the NCGRT's International Scientific Advisory Committee, a committee established to review the Centre's research programs and provide advice on an on-going basis.

The Committee comprises Emeritus Professor Ghislain de Marsily (University of Paris, France), Professor Edward Sudicky (University of Waterloo, Canada), Professor Peter Loucks (Cornell University, New York) and Dr Leonard Konikow (United States Geological Survey, Virginia).

"The Committee members are truly the masters and pioneers of groundwater in the world and to have the benefit of their knowledge and advice is simply fantastic," Professor Simmons said.

"We received very positive feedback on the direction of the Centre's programs, the scientific novelty and international significance of the research, and of the leadership and ability of the group to conduct that research," he said.

The Advisory Committee reviewed and discussed the five streams of the NCGRT's research program, which include:

- Addressing the critical shortage of knowledge of Australia's sub-surface water systems with new field work and three dimensional geological models,
- Collaborating with physicists, engineers, mathematicians, chemists, geologists and remote sensing experts to develop new groundwater simulation tools,
- Developing techniques to understand the connectivity between surface water and groundwater,
- Building knowledge of the relationship between groundwater and vegetation and how this might be affected by climate change and low rainfall,
- Engaging with the community and using the new knowledge gained from the research programs to inform and explain decision-making in regard to groundwater.

"We're told that a lot of people around the world are talking about the Centre. There is a strong international buzz about our work and programs which will put Australian groundwater research on the world map."

Emeritus Professor de Marsily, Professor Sudicky and Professor Loucks also delivered seminars to packed audiences of students, academics and industry and government water specialists during their visit.

Professor Simmons said the NCGRT was keen to further expand its international links and engage with water professionals around the world.

*Contact: Professor Craig Simmons*
*Director, National Centre for Groundwater Research and Training*
*craig.simmons@flinders.edu.au*
www.groundwater.com.au

# USC focuses on sustainability

Professor Helen Wallace and Associate Professor David Lee.

Professor Tim Smith.

The University of the Sunshine Coast in Queensland, Australia, is leading and supporting change for a sustainable environment. USC's teaching and research goals are heavily influenced by the desire to boost sustainability measures at local, regional, national and international levels.

The University's spacious, growing campus also is designed as a model of sustainability, with award-winning buildings surrounded by native flora and fauna, including a resident kangaroo population. This workplace forms part of an enviable environment on the Sunshine Coast, which seeks to be the most sustainable region in Australia.

Three outstanding fields of sustainability research at USC are climate change adaptation, forestry and aquaculture.

## Climate change

USC has established a transdisciplinary Sustainability Research Centre focusing on the social dimension of environmental change through research into key sustainability issues and regional engagement. This includes study into sustainability science, resilience, adaptive capacity, adaptive management, social learning, social and human capital, community engagement, and sustainable regional development.

The Centre deals with issues involving coastal management, climate change, water management, natural and cultural heritage, and community wellbeing.

Centre Director Professor Tim Smith is involved in research projects of national and international significance. In 2009, Prof. Smith and his research partners received a prestigious Australian Museum Eureka Prize for Innovative Solutions to Climate Change.

Professor Smith jointly led the research with representatives from the Sydney Coastal Councils Group, WWF and the CSIRO on a three-year project that assessed Sydney's ability to adapt to future climate conditions.

It considered climate hazards, such as heatwaves and storm surges, as well as decision-making and socio-economic factors that are likely to play significant roles in influencing the impacts of climate change.

Professor Smith said the project identified that helping local governments reduce the vulnerability of communities, businesses and other groups to the impacts of climate change was a major challenge.

"Our team proposed steps for local governments to build that capacity," he said. "We've also helped build a conversation on climate change within and between local governments."

Professor Smith is currently involved in a similar climate change adaptation project for South East Queensland, which represents Australia's single largest integrated climate adaptation research initiative at the regional scale.

He is leading the Adaptive Capacity Theme of the South East Queensland Climate Adaptation Research Initiative, a project involving the Queensland and Australian Governments, the CSIRO Climate Adaptation National Research Flagship, the University of Queensland and Griffith University.

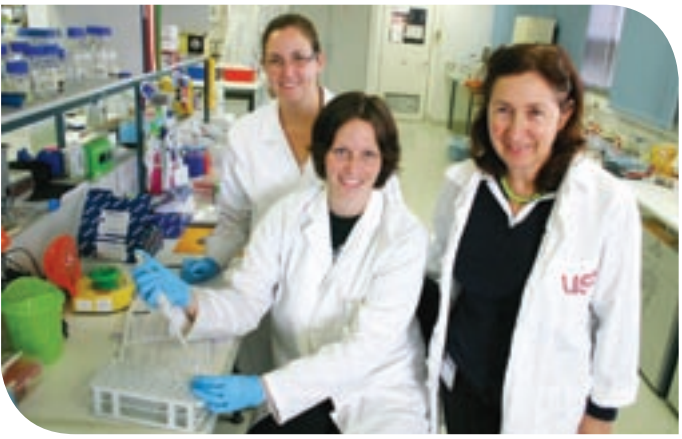
Students at USC can choose major or minor study programs in sustainability. A Graduate Certificate in Sustainability was introduced in 2009 to satisfy strong industry demand for staff with skills and knowledge in issues such as sustainable resource management and climate change.

A world-first Master of Climate Change Adaptation produced its first graduates last year. They were qualified to advise governments and businesses on how to prepare for and respond to the likely effects of climate change.

## Forestry

USC Professor in Agricultural Ecology Helen Wallace is continuing to develop new research directions in trees and climate change. She manages a research portfolio of $4 million in forestry, horticulture and climate change projects and is working closely with industries such as hardwood forestry, macadamia and canarium.

Professor Wallace is involved in a $10 million, four-year Australian



Professor Abigail Elizur with students Kelli Anderson and Rebecca Morgan.

project to boost agribusiness in Pacific island countries. She is investigating sustainable ways of creating high-value products from canarium, a local tree nut, and local timber such as whitewood and teak. USC was one of four national universities commissioned by the Australian Centre for International Agricultural Research for the Pacific Agribusiness Research for Development Initiative.

USC Associate Professor in Plant Genetics Dr David Lee is leading a large collaborative project to assess how fast-growing tropical hardwood trees can be better used to combat climate change. Dr Lee is also a Senior Principal Research Scientist with Agri-Science Queensland in the Department of Employment, Economic Development and Innovation.

The project, which received a $300,000 federal government grant in May, involves USC, CSIRO Plant Industries and Agri-Science Queensland. It establishes the group as the major tropical forestry research provider for Australia in addressing climate change. It will examine the drought adaptation and carbon sequestration rates in tropical hardwood plantations, enhance the forestry sector's knowledge of tropical trees adapted to drought, and enable the sector to participate in ground-breaking sustainable carbon pollution reduction schemes.

Another USC project is dedicated to establishing a "greener" hardwood forest and timber industry in Queensland. USC plant scientist Dr Stephen Trueman leads the project, which received a State Government grant of $875,000 and involves 14 researchers from the Department of Primary Industries and Fisheries and CSIRO. It aims to reduce dependency on timber from native hardwood forests.

## Aquaculture

Professor Abigail Elizur is the Director of USC's GeneCology Research Group and a leading researcher in the field of aquaculture biotechnology. Her work with the world-first spawning of southern bluefin tuna in captivity at the Clean Seas Tuna facility at Arno Bay in South Australia drew accolades from around the globe and was recognised by America's *Time Magazine* as the second most significant invention in the world for 2009, behind NASA's new Ares rockets.

"This project is a triumph of planning and persistence with great Australian entrepreneurs who believed in the role science can have," she said.

"It was supported by the Australian Seafood Cooperative Research Centre and has opened up huge opportunities commercially, as well as environmentally in preserving wild fish stocks."

She said it was a thrill to be part of a collaborative team of scientists, brought together by Clean Seas Tuna Chairman Hagen Stehr AO, which included researchers from Australia as well as the Center of Marine Biotechnology at the University of Maryland in the United States, and from the European Tuna Consortium.

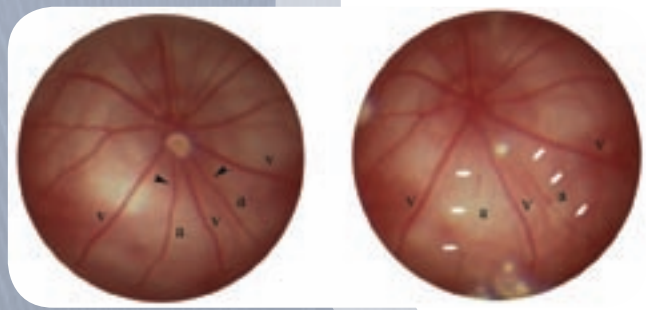
Professor Elizur's expertise in fish reproductive physiology and advancing genetic studies using genomics have enabled USC to become an important contributor to the Australian Seafood Cooperative Research Centre (CRC) and other major research.

Among Professor Elizur's current projects is one aimed at "climate-proofing" Tasmania's $270 million salmon aquaculture industry. This project, led by Griffith University in partnership with USC and Salmon Enterprises of Tasmania, has received funding from the Federal Government's Fisheries Research and Development Corporation. Researchers are examining the impact of temperature variations on Atlantic salmon breeding stock of different ages in Tasmania in a bid to improve the survival rate of eggs.

The GeneCology Research Group operates in the areas of genetics, ecology, genomics and physiology and the interaction between these. It addresses issues of sustainability through research on sustainable production of aquaculture horticulture and forestry systems, biodiversity conservation, and sustainable urban forestry and horticulture.

Together, the research these scientists and their teams complete every day is taking all of us into the future. Their work focuses on practical outcomes for the community that are environmentally sustainable, ecologically feasible, culturally sensitive, and economically viable. ■

# The Vision Centre



## ARC Centre of Excellence in Vision Science
## "Vision for life"

### OUR MISSION

*"to address the most challenging and urgent problems in vision science"*

### ABOUT THE CENTRE

The Vision Centre aims to be an international leader in the early detection, prevention, and treatment of blinding disease, and in visual robotics. Our researchers are amongst the highest ranked vision scientists in the world.

The Vision Centre encompasses staff from four Australian universities and it has more than 140 members. In addition to our 17 Chief Investigators, the Centre has formal links with 12 other academic and commercial partners and its researchers have built collaborations with many national and international institutions.

### THEMES

The Vision Centre's research covers the following themes:

1. Visual processing and robotics:

(a) understanding how visual systems process information; and

(b) the application of this understanding in the design and development of robotic visual systems.

2. Blinding diseases:

(c) understanding how visual systems develop and what keeps them stable; and

(d) the application of this understanding in overcoming blinding diseases.

www.vision.edu.au

THE AUSTRALIAN NATIONAL UNIVERSITY

THE UNIVERSITY OF QUEENSLAND AUSTRALIA

THE UNIVERSITY OF SYDNEY

THE UNIVERSITY OF WESTERN AUSTRALIA

Physics and Biology meet at The University of Western Sydney.

# Synergies through imaging

The National Imaging Facility (NIF) was established in 2007, as part of the National Collaborative Research Infrastructure Strategy (NCRIS). NCRIS marks a new paradigm for the funding of major infrastructure in Australia, whereby the needs of the community are to be identified through a nationwide consultation process.

Access to facilities is based on merit, and must be opened to the wider scientific community. Imaging was identified as a component of the Characterisation Capability, together with the Australian Microscopy and Microanalysis Research Facility, the Australian Synchrotron and the National Deuteration Facility. The Characterisation Council provides support and advice to all four sub-capabilities, advising government on further requirements. It also provides a forum, whereby the four sub-capabilities can share an ethos for complementary use of the technologies, as well as to identify synergies to give a capability that is greater than the sum of its parts.

The NIF is strongly aligned, both in its strategic approach and specific objectives, with the recommendations for development of national research capabilities outlined in the 2006 and 2008 Strategic Roadmaps for Australian Research Infrastructure. It is supported by the results of extensive consultation with the research community, funding providers, industry and government agencies at state, territory and federal level. The founding nodes, The University of Queensland (lead institution), University of Sydney, University of New South Wales, The University of Western Sydney, The Florey Neuroscience Institutes, Monash University and Large Animal Research Imaging Facility (LARIF, a collaboration between South Australia Pathology, University of Adelaide and University of South Australia) are focussed on development and validation of biomarkers. The National Imaging Facility provides state-of-the-art imaging of animals, plants and materials for the Australian research community, with a range of leading-edge imaging instrumentation.

An important component of the NCRIS vision is access to resources that will provide the research community with expert advice and assistance in the optimal use of imaging. As a sign of commitment to collaboration, the founding nodes pledged significant access to their existing resources, ensuring that all Australian scientists have access to world-leading technology. LARIF provides a complete research environment, including operating theatres, animal husbandry and imaging, so that longitudinal experiments can be established and the researcher has the confidence that the animals will be cared for, and the needs of the experiments delivered with utmost professionalism. The Sydney node of the National Imaging Facility, located at the Brain and Mind Research Institute in the Camperdown health research precinct, is concerned with the development of novel biomarkers (drugs and imaging probes) and non-invasive imaging technologies that are used to improve our understanding of disease. It will include a research cyclotron, radiopharmaceutical development and molecular imaging, offering a one-stop shop, critical for short-lived isotopes such as C-11, but also the ability to ship tracers based on longer-lived isotopes to other facilities.

Looking down the bore at the Large Animal Research Imaging Facility in Adelaide.

In addition to the instrumentation funded by the initiative, the NIF provides access to a federated bioinformatics capability. A key aim of NIF is to develop databases of normative data, to remove the need for duplication of effort and reduce the number of animals required for research.

The NIF has recently received a A$40.2m injection from the Education Investment Fund, as part of a A$106m expansion program, extending NIF to include The University of Melbourne, Swinburne University, The University of Western Australia and ANSTO. The consortium, incorporating 12 institutions, includes all Australian universities with a significant research and education presence in imaging, and serves as a springboard for national and international collaborations.

www.anif.org.au

# Small Island – Big Discoveries.

The University of Tasmania is ranked as one of Australia's top 10 research universities. UTAS offers globally significant programs in areas such as:

**Environment** – Tasmania's unique wilderness, wildlife and World Heritage areas provide focus for terrestrial ecology, land management, and sustainable design;

**Antarctic and Marine Science** – UTAS fosters strong collaborations with marine and Antarctic research agencies through the Institute for Marine and Antarctic Studies (IMAS);

**Sustainable Primary Industry and Mining** – New research outcomes provided by UTAS researchers support the agriculture, aquaculture and fisheries, forestry and mining industries; and

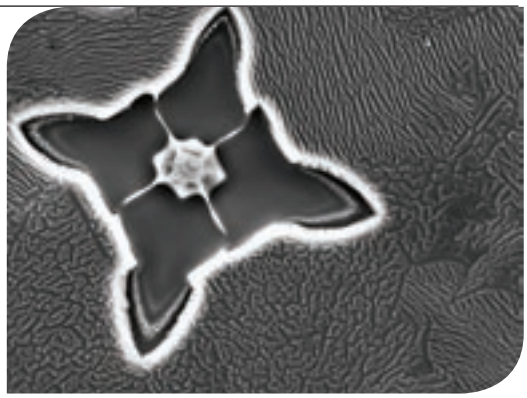
**Frontier Technologies** – Programs include major initiatives in separation science, human interface technology, radioastronomy, renewable energy and power engineering.

For more information on research opportunities at UTAS, contact the Faculty of Science, Engineering and Technology by calling +61 3 6226 2125, email set.enquiries@utas.edu.au or log onto **www.utas.edu.au/set**

UTAS

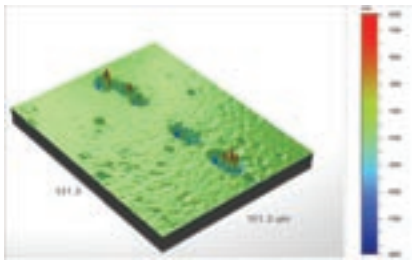
2529

# Linking research and engineering



RIGHT: Microstructure of Al-2wt%Sc showing the primary eutectic Al3Sc (flower-like shape) and the matrix of alpha-aluminium and Al3Sc.

ABOVE: Asymmetric failure mode in three-point bending of a foam–cored sandwich panel with a span length of 50mm.



RIGHT: Typical 3D optical profilometry image showing the pits around the existing cathodic phase particles in AA7150 alloy.

The ARC Centre of Excellence for Design in Light Metals is a multi-nodal national research centre of leading Australian materials researchers that is driving internationally-competitive development in light metals research. The Centre is headquartered at Monash University, and has major collaborating nodes at the University of Melbourne, Deakin University, the University of Queensland, the University of Sydney and the University of New South Wales.

The Centre of Excellence coordinates internationally-competitive national research strengths to establish a strategic fundamental research platform for expansion of the light metals industry nationally. It embraces a novel 'design-directed' approach to the systematic identification of strategic research initiatives that will maximise the competitiveness of light alloys and light metal hybrid materials based on aluminium, magnesium and titanium.

The Centre addresses strategic design targets identified in light metal applications through:

- novel approaches to the design and processing of conventional light alloys to modify existing property profiles, including production of existing properties more economically, and;
- innovative approaches to design with and applications of light metal systems to create novel property profiles that expand applications of the light metals.

The 'design-directed' approach provides an effective linkage between fundamental research and engineering applications. Coupled with a focus on genuine innovation in materials design and advances in downstream processing, it ensures that the Centre fills a critical void in the national light metals research strategy and provides a vital link between research and industry sectors. Typical research areas of the Centre include:

## Alloy Design and Processing

- Design of Al structures for enhanced strength
- Design of Mg structures for enhanced strength
- Design of structures for enhanced ductility
- Design of structures for enhanced performance

## Titanium

- Hydrogenated pre-forms
- Equal channel angular extrusion of Ti powder
- Powder processing
- Alloy development

## Hybrid Structures

- Composites macro- and meso-scale
- Micro- and nano-scale hybrids

## Surface Engineering

- Surface properties of Mg alloys
- Durability of light alloys
- Surface coatings and cladding
- Wear resistant light alloys
- Gradient structures

The Centre welcomes engagement with industrial partners, and offers coordination of multi-institutional research capability and the opportunity for leverage of research support. It strongly encourages the support and assistance of industry and government-sponsored schemes in the identification of strategic design targets and the setting of research priorities. To foster increased collaborative research partnerships with industry, the Centre of Excellence offers a formal industry associates program. A key element of this Program is to facilitate direct engagement with individual Australian and international industry partners to ensure substantive end-user input to the directions of the Centre's research program.

*Contact details:*
*ARC Centre of Excellence for Design in Light Metals, Department of Materials Engineering*
*Monash University*
*Wellington Road, Clayton, VIC, 3800, Australia*
*Ph. +61 3 9905 5247, Fax: + 61 3 9905 4940*
*edna.tan@monash.edu.au*
www.arclightmetals.org.au

# RESEARCHING for the future

The complex issues of our time demand robust answers. The resolution of existing questions and the inspiration for tackling new ones are most efficiently found by dedicated researchers from many fields of study. The scale and nature of challenges and problems in Australia and its regions have a great deal in common with those of the European Community. How to approach our shared problems and secure our futures is a matter for our governments, advised and supported by researchers and the knowledge they provide.

We can all agree that understanding the origins, dynamics and effects of mega-phenomena, such as climate change, is primarily achieved through research in the physical sciences. However, understanding the necessary governmental and human behavioural responses to climate change is a concern directly in the focus of the Academy of the Social Sciences in Australia (ASSA). In order to address such crucially important problems, such as the causes of climate change, the mitigations and adaptations to it, or the host of other challenges to sustainable civil societies, wise governments can enlist the aid of the research community. It is clearly in the interest of the research communities and their governments to combine their wisdom and research strengths to provide secure and harmonious futures for their peoples. ASSA is committed to contributing to the best outcomes.

Australian social scientists, much like their European counterparts, now commonly work across disciplines, combining strengths to provide power and breadth to their research networks in addressing large-scale issues. In one instance, Australian social science researchers in disciplines including law, psychology, politics, geography and others combine formidably to contribute excellence in the theory and practice of environmental regulation and governance. In another social science network, researchers in such disciplines as demography, economics, sociology, statistics, education and social medicine bring evidence-based research to bear on policies relating to the health and ageing of 21st century Australia, where new ideas and innovation are in ever-increasing demand.

The Australian Research Council and the National Health and Medical Research Council have established and funded multidisciplinary Research Networks to support this research and its translation into public policy. This research has included considerable international collaboration through the World Health Organisation and partnerships with European researchers and funding networks. The aim of these collaborative efforts is to better understand societal impacts on health and to consider the ways in which alternative policy approaches can impact on health and wellbeing.

The culture of innovation in the social sciences leads to new and clever ways of doing things that improve critically important aspects of the national social environment. Consider for instance the affordable funding of an expanding higher education sector through the application of contingent loans, a scheme devised in Australia which allows students to defer the payment of their tuition until, and only if, their future incomes are high. This approach to university funding has now been exported to, among other countries, New Zealand, the UK, Hungary, South Africa, Malaysia and Ireland, and is under serious consideration in many others. We believe that this type of financing approach has great potential in many other aspects of social and economic policy, and Australian social scientists have already developed sophisticated applications of the mechanism in areas as diverse as drought relief, paid parental leave, R&D investments, elite athlete financing, venture capital and rent relief for the disadvantaged.

## POLICY AND ADVOCACY

**One Academy program, Policy and Advocacy, provides roundtables where social scientists join with senior government officials and other experts to inform policy makers of the latest policy-relevant research, such as 'Regulation, Environment Protection and Natural Resource Management'. This drew upon law, politics, geography and other disciplines to address the most appropriate mix of regulation and other policy devices for the delivery of sound environment protection and natural resource management outcomes. This is just one example of a working application in which collaborative effort between Australian and European researchers and policy-makers could lead to a richer dialogue and be of benefit to all participants.**

The affiliation between Queensland University of Technology and National Chengchi University resulted in the project *Flood and fire: understanding public communications in times of Crisis*. The Academy of the Social Sciences in Australia announced this project to be developed in the International Science Linkages program.

*Extinction in multi-species communities: moon bear case study* is a project between Macquarie University and Providence University. It was approved by the Academy of the Social Sciences in Australia, as a part of the International Science Linkages program.

> Australian social scientists, much like their European counterparts, now commonly work across disciplines, combining strengths to provide power and breadth to their research networks in addressing large-scale issues

The Academy of the Social Sciences programs support research in Australia across the full spectrum. Economic benefits, health strategies, living standards, educational outcomes, the rule of law, regulatory and governance frameworks all feature in providing strategies for increased social inclusion, and improved qualities of life that are equitable, productive and sustainable.

Australia is an immigrant nation that is at the forefront of evidence-based development of immigration policy. It designs its immigration policy to promote rapid settlement and economic integration, provide skills that are in high demand, reduce the pressures of an ageing population, attract entrepreneurs with capital, reunite and to provide a haven for refugees. Its relative success in achieving these goals can be explained in large part by the systematic collection of high quality data on the migrant experience and insightful academic and official analyses of the many issues surrounding a large scale immigration program.

The ASSA maintains a very active international program, supported generously by the Australian Department of Innovation, Industry, Science and Research's International Science Linkages Program, which promotes collaborations between Australian early career and established researchers and counterparts in the European Community, Asia and North America. Bilateral and multilateral research teams made up of social scientists and collaborators from the science and technology sector are currently being funded by ASSA to engage in research topics. These include:

- maritime spatial planning in the Baltic Sea region: lessons from the Great Barrier Reef;
- socio-economics of scientific and technical human capital;
- controlling corruption – transnational issues;
- extinction in multi-species communities: moon bear case study, and;
- flood and fire: understanding public communications in times of crisis.

These and other studies underline ASSA's enthusiasm for working across disciplines and between sectors to engender the culture of collaboration where mutual interests are clear, inviting, and promise to fortify research objectives and strengthen bonds between researchers and their countries. There is much to understand about multiculturalism and nationality, harmonious societies and conflict, trade and exchange, migration and refuge, productivity, population and sustainability. These matters demand the broadest and strongest contributions that our researchers can provide, and the wisest policies that our governments can conceive.

As the President of The Academy of the Social Sciences in Australia, it is my ambition that research bonds between us and European scholars will help us all better understand and prepare for our changing environmental and social circumstances.

*Professor Barry McGaw, AO*
*President of the Academy of the Social Sciences in Australia*

# The National Youth Science Forum
## a gateway to global science

After humble beginnings in 1984, the National Youth Science Forum (NYSF) has become one of Australia's elite residential science camps and the gateway for young Australians to attend prestigious international forums.

The NYSF was set up with two key objectives:

1. To address the needs of students who are interested in the sciences and engineering, and to show them the breadth and depth of career options beyond bench research.
2. Addressing the critical issue of the national shortfall of scientists and engineers across all fields, as currently reflected by university enrolments and industry across the country. Numerous academic papers and government/ industry reports have discussed the growing concern over persistent declines in post-compulsory high school science enrolments over the last two decades in many countries, including Australia. It is clearly recognised that the increasing reluctance of students to choose science courses has important implications not only for the health of scientific endeavour in these countries, but for the scientific literacy of future generations.

To achieve these objectives the NYSF runs four core programs. The first is a residential program with 450 final year high school students, selected by Rotary, who experience real world science at three of Australia's leading universities, the Australian National University, Curtin University of Technology and the University of Western Australia. Living in an on-campus environment allows the students to feel comfortable in their next educational step and introduces them to scientists and engineers undertaking breakthrough research.

Following the forums, which are held each January, a core group of students are selected to undertake a Leadership Training course. These students will in turn run the following year's program. This training includes both a five-day course run on the NSW South Coast and a five-day trek through the Pilbara in Western Australia, where the students immerse themselves into the Australian indigenous culture while realising their true leadership potential.

The third component of the Forum is a series of university and industry seminars. Held in seven locations around the country, leading universities open their doors exclusively to NYSF students, allowing them to gauge the feeling of different campuses and the scope of courses and research available. Site visits are also held at multinational companies and government agencies including ExxonMobil, CSL, Woodside, ANSTO and Cochlear.

As well as showcasing elite domestic science and engineering, the NYSF is the exclusive avenue for Australian students to attend international science programs. For over 20 years the NYSF has forged relationships with eight international programs, which can be separated into two categories.

The following programs run forums

> "the endless life lessons and scientific knowledge I have gained is not something that could be taught in a classroom. The maturity, independence, cultural appreciation and inspiration that the National Youth Science Forum and the Canada Wide Science Fair has offered has changed me"
>
> *– Dominique Tynan, 2010 Canada Wide Science Fair representative*

The 2010 group of students from Australia in the Rockies after the Canada Wide Science Fair.

Students hiking through the Pilbara in the north of Western Australia as part of the leadership training.

to which they invite NYSF students to participate:

- London International Youth Science Forum;
- Canada Wide Science Fair, run by Youth Science Canada;
- Russian Scientific Study Tour, run by the All-Russian Youth Aerospace Society (Soyuz);
- EuroScience Open Forum (ESOF);
- National Youth Science Week, Pretoria, South Africa; and
- Stockholm International Youth Science Seminar (SIYSS), run parallel to the Nobel festivities with students attending the laureate's dissertations, the Nobel prize ceremony, ball and banquet.

Two further international programs are research-based and involve Australian students immersing themselves in up to six weeks of scientific research under one-on-one mentorship. These programs are:

- Research Science Institute, held at MIT, run by the Centre for Excellence in Education in Washington DC; and
- International Science Summer School Heidelberg (ISH).

How do these programs tie in with the NYSF's key objectives? By giving Australian students opportunities to engage with people at the forefront of new technologies both locally and internationally we're breaking through the misconception that there are limited careers in science and engineering.

Now in its 27th year, the NYSF has a vast group of alumni achieving high accolades in all areas of science. Past students have gone on to become Rhodes Scholars and are forging ahead in areas such as photonics and environmental engineering. Of the students who attend the forum, 86 per cent of them move into careers in the science field, with many research based alumni being appointed to academic positions in leading universities in the USA and UK. Others have been appointed to corporate positions and are taking leading roles in multinational organisations.

In essence, the success of the NYSF can be summed up by past student Sheena D'Arcy (1999), a Rhodes Scholar currently undertaking further studies in the USA. "The NYSF helped me to make an informed choice about university and my career. Interaction with current science professionals reaffirmed my scientific ambitions, while seminars outlined the process of achieving them. Through the culture of excellence fostered at the NYSF, I developed skills that enabled me to follow my aspirations, found similarly-minded mentors and peers, and, most importantly, became excited about my future."

*Lucy Wedlock,*
*Marketing and Communications Officer, NYSF*

*More information about the program can be found at* www.nysf.edu.au

> "the Research Science Institute program provided me with an awesome experience to undertake my own research project. This gave me a valuable insight into the nature of research within a company setting, as well as the diverse group of academics I can expect to meet at university. The RSI family of which I am now a part, will also continue to support me into the future, with a rich tradition of community"
>
> *– Fern McAllan, RSI participant, 2007*

# Forestry project targets *climate change*

USC's climate change research received a boost in May with a $300,000 federal government grant to assess how fast-growing tropical hardwood trees can be better used to combat climate change.

The large collaborative project—involving USC, CSIRO Plant Industries, and Agri-Science Queensland—establishes the group as the major tropical forestry research provider for Australia in addressing climate change.

The project will assess the drought adaptation and carbon sequestration rates (the rates at which trees absorb carbon from the air) in tropical hardwood plantations.

It will enhance the forestry sector's knowledge of tropical trees adapted to drought, and enable the sector to participate in ground-breaking sustainable carbon pollution reduction schemes.

The grant from the government's Forest Industries Climate Change Research Fund was for the Forestry Adaptation and Sequestration Alliance project.

*Project leader Dr David Lee is Associate Professor of Plant Genetics at USC and a Senior Principal Research Scientist with Agri-Science Queensland in the Department of Employment, Economic Development and Innovation.*

# PhD students the key to the future of research

Australia is an innovative nation that is among the world's leaders in medical research, environmental and resource sciences, advanced materials and many other areas. Although less than half a per cent of the world's population, Australia accounts for nearly three per cent of the world's research output.

Many recent advances, such as the Gardasil cervical cancer vaccine, originated in Australian universities, were quickly and effectively translated into global products. Compared to overseas peers, Australia's research effort is overwhelmingly concentrated in universities, with this sector being among the most globalised and technologically sophisticated of all Australian industries. Overall, approximately three-quarters of private sector patents in Australia draw on public sector research by universities and agencies such as the CSIRO. Universities also train the majority of researchers in Australia, creating a base for future innovation in old and new industries.

Research training is a core aspect of the work of Australian universities, which have a proud history of producing world-leading researchers in a wide range of fields. Universities regularly highlight the fact that PhD and early career researchers often undertake some of the most exciting work in Australian universities in their own right, as well as gaining the skills to drive Australia's future innovation and research performance.


International enrolments in PhD programs represent the elite end of student recruitment. These students make their choice of university based on the quality of the program and the facilities and expertise that will be available to them during their studies. Australian universities are actively pursuing these top-quality students for the overall benefit of their research programs, but also for the long-term benefit of Australia, should these highly skilled people choose to seek permanent residence. Universities are advocating for lecturers and tutors (across all disciplines) to be included on the government's revised Skilled Occupations List for migration purposes.

**3%** **Australia's contribution to the world's research output**

Australia's then Education Minister, the Hon. Julia Gillard confirmed on 16th March 2009 the importance of international PhD students: "These research scholars help build Australia's future research capability and academic workforce. They become both the source and conduit of the new knowledge, ideas and technologies that Australia will continue to need, if we are to meet the local and global challenges that lie ahead". ■

## PHD STUDENT NUMBERS GROWING

Over the nine years between 1998 to 2007, numbers of international postgraduate research students in Australian universities grew, on average, 10 per cent per year. In 1998, 4047 international postgraduate research students made up 11.4 per cent of Australia's 35,577 postgraduate research students. In 2007, after growth of 10.3 per cent per year, the number of international postgraduate research students had more than doubled to 9836, 19.7 per cent of Australia's 49,819 postgraduate research students. The Australian Government is seeking to increase these numbers further (and attract students from developing countries in particular) by increasing the number and value of International Postgraduate Research Scholarships (IPRS), and support through AusAID programs.

# SOLUTIONS
## for some of the world's most pressing challenges

### STATE-OF-THE-ART RESEARCH FACILITIES AT UQ

The University of Queensland, in partnership with government, industry and donors, has invested strategically in areas where it has critical mass, to develop globally-recognised interdisciplinary research institutes that support a broad and comprehensive research profile. Facilities which combine modern infrastructure, state-of-the-art technology and a culture of research excellence, the UQ Institutes are the Australian Institute for Bioengineering & Nanotechnology (AIBN), Diamantina Institute, Global Change Institute (GCI), Institute for Molecular Bioscience (IMB), Institute for Social Science Research (ISSR), Queensland Brain Institute (QBI) and Sustainable Minerals Institute (SMI).

Breaking new ground to uncover solutions for some of the globe's most pressing challenges is the driving force behind the pioneering projects of researchers from across science at The University of Queensland (UQ) and their European collaborators.

The Seventh Framework Programme for Research and Technological Development (FP7) and institutional, industry and private partnerships are driving advancements in energy-efficient technology, laser science, sustainable industries, climate change and environmental management.

UQ Professor Halina Rubinsztein-Dunlop said collaboration with four European university research groups ensures innovative research and knowledge transfer at the highest level.

"Our collaborative research in laser micromanipulation and quantum science involves visits by academics, postdocs and PhD students and allows for information sharing among leading scientists," Professor Rubinsztein-Dunlop said.

"We've conducted research in each other's labs and shared results and ideas about future developments in laser micromanipulation and applications in biosciences and medicine."

Halina Rubinsztein-Dunlop in front of laser micro-manipulation set-up.

The collaboration began in 2007 with Medical University of Innsbruck in Austria, University of Münster in Germany, and the Universities of St Andrews and Glasgow, both in Scotland.

Funding for this project is received from the Australian Academy of Science and the European Union Network COST Action.

Similar levels of leading-edge research and information sharing is taking place between European and Australian researchers on energy efficient technology.

### UQ STUDENTS TOP OF THE WORLD IN AIRBUS COMPETITION

A team of students from The University of Queensland won the inaugural Airbus Fly Your Ideas challenge in 2009 at the Paris-Le Bourget Air Show.

The COz team won for its project on the use of the castor plant to develop the first-ever single plant-based high-performance composite materials for aircraft cabin components.

The goal is to reduce dependency on non-renewable sources and improve end-of-life disposal, thus contributing to a reduction of aviation carbon footprint.

They conducted a comprehensive feasibility analysis entailing fibre production and testing, demonstrating very encouraging mechanical and environmental properties.

The multinational COz team is part of a collaborative program between UQ and CRC Advanced Composite Structures. It comprises team leader, Michael Heitzmann (27), of Swiss origin and Alex Ng (25), originally from Hong Kong, both PhD students in Mechanical Engineering, and Benjamin Lindenberger (26), from Germany, an Aerospace Engineering student who is undertaking his University of Stuttgart diploma thesis at The University of Queensland.

The multinational Coz team, part of a collaborative program between UQ and CRC Advanced Composite structures.


## RESEARCH INTO IMPROVED CORAL REEF MANAGEMENT

Professor Peter Mumby, who recently joined UQ from the United Kingdom, leads a multinational consortium of natural and social scientists to help sustain the ecosystem services of coral reefs.

The project, Future of Reefs in a Changing Environment: An ecosystem approach to managing Caribbean coral reefs in the face of climate change (FORCE), is a consortium of 18 partners from 10 countries.

The project partners are mainly higher education institutions such as the University of Amsterdam, the Universities of Exeter and Newcastle, in England as well as the Universities of the West Indies, Barbados and Costa Rica.

The project commenced on 1 January 2010 with €6,474,000 for four years from the European Commission Framework 7 program.

Because of the geographic spread of the partnership, there is great scope for knowledge transfer between the regions, including opportunities for PhD student exchanges.

ABOVE: Prof Mumby on Boat

LEFT: Heron Island

Professor Paul Burn at UQ's Centre for Organic Photonics & Electronics (COPE) has three projects with European entities.

One project aims to develop a new imaging technology to improve the quality of photos taken by digital cameras with a logarithmic response. Under the program, UQ provides new materials, device ideas and other relevant information to research partners. The project commenced in 2007 and involves world expert on imaging and cameras, Dr Steven Collins of Oxford University and leading condensed matter physicist, Professor Ifor Samuel of the University of St Andrews.

UQ scientists and their European collaborators have also been at the vanguard of climate change and coral reef research, making great discoveries and contributing to solutions that help protect fragile environments and ecosystems.

UQ Professor John Pandolfi has teamed up with a renowned reef palaeontologist from Humboldt University in Berlin on a project predicting coral reef response to climate change. The German and Australian labs share high levels of knowledge on ancient coral reefs to enable a global-scale study.

"The benefits to Germany include a deeper understanding of tropical marine ecosystems, and marine managers from both Australia and Germany benefit from long-term information about what was natural in the sea before human impacts began to dominate seascapes," Professor Pandolfi said.

Whether collaborations are with partners in research institutions or in industry, these UQ-European partnerships take many varied and flexible forms of collaborations to bring successful research outcomes, and demonstrate the collaborators' exceptional abilities to innovate, develop new technologies, and find solutions to current global issues. Importantly, collaborations are leading the way for greater information sharing and cultivating the minds of budding early career scientists who will pave the path for the future. ■


Griffith
UNIVERSITY
Queensland, Australia
our research revolves around the earth
With a dedicated international perspective, Griffith University has created research partnerships with more than 20 countries throughout Europe. Some of our partners include the Smithsonian Institute, Pro-Natura International and Institut Pasteur. Exploring innovative and potentially world-changing study areas means Griffith's research knows no boundaries, geographic or otherwise.
To find out more about Griffith's pioneering research visit www.griffith.edu.au/research
GRIFFITH UNIVERSITY
Gold Coast - Logan - Mt Gravatt - Nathan - South Bank
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# Sharing knowledge for global solutions

Professor Mark von Itzstein (Institute for Glycomics)

Griffith University scientists are working together with the international research community to create a sustainable future through initiatives that range from tackling water management and climate change adaptation to developing new technologies and quantum computing. The Eskitis Institute, the Institute for Glycomics and the Environmental Futures Centre make up just three of the 35 research centres at Griffith undertaking pioneering work in their respective field.

## Setting climate change alert

The Environmental Futures Centre (EFC) in partnership with the Smithsonian Institute, Pro-Natura International (Paris) and Chinese Academy of Sciences are investigating the biodiversity of animals and plants in the Lamington National Park, Queensland.

Professor Roger Kitching says these groups of animals, particularly insects, are the best indicators to detect the present and future impacts of climate change in tropical and sub-tropical regions, leading to effective adaptive strategies.

"Climate change is probably the single greatest factor that will impact on the future of the world and to be able to do research that helps us to understand and subsequently cope with that, is really important for all mankind," Professor Kitching said.

The study in Lamington National Park is the Australian-arm of the international project, IBISCA (Investigating the Biodiversity of Soil and Canopy Arthropods), which also has sites in Panama and Vanuatu.

Professor Ron Quinn

## Unlocking nature's remedies

Griffith's Eskitis Institute hosts a globally important biological resource with enough biota to last 100 years of drug discovery activity. Known as Nature Bank, it is a library of more than 45,000 samples of plants and marine invertebrates from tropical Australia, Papua New Guinea and China.

Professor Roger Kitching

Eskitis Institute Director Professor Ron Quinn said the collection was established as part of an investment of A$100m from AstraZeneca, which was one of the most successful private-public research partnerships between Australia and Europe.

"Nature Bank continues to grow everyday and provides fractions pre-selected for favourable physicochemical properties", Professor Quinn said. "Today, the resulting screening set has more than 200,000 high quality natural product fractions. It offers an efficient and rapid method to identify potential drugs from natural products."

The Institute has attracted major European industry and academic partnerships in natural product drug discovery, including Actelion, Creative Antibiotics, Medicines for Malaria Venture, Drugs for Neglected Diseases initiative, University of London and Cambridge University.

## Fighting viruses

Griffith's Institute for Glycomics has partnership agreements with the leading Institut Pasteurs in France, Vietnam and Cambodia to jointly undertake research in anti-infective/viral and early stage drug development.

Professor Mark von Itzstein, Director of the Institute for Glycomics, said the specific research focus would be the discovery and development of new generation anti-influenza drugs on emerging influenza strains in Asia as part of a rapid response plan to fight a future pandemic.

"The world is ill-prepared to tackle existing and emerging viruses due to the lack of available drugs and vaccines," Professor von Itzstein said.

"In Asia, we only have to remind ourselves of the deadly avian flu to realise their potential impact."

*Griffith University partners with leading research institutes in the world to create cross-disciplinary solutions to global issues. To find out more, visit: griffith.edu.au/research*

# EXCELLENCE in research

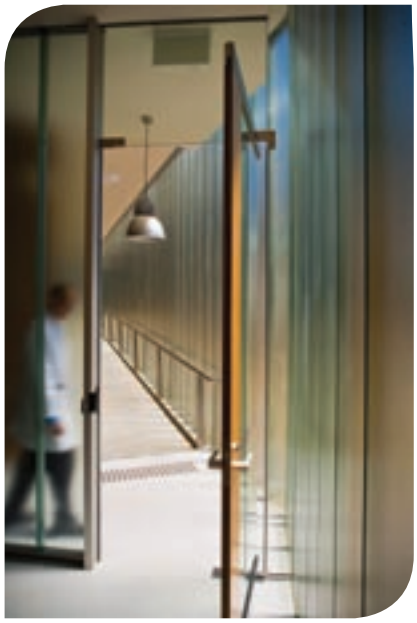
Monash University is Australia's largest university, and widely regarded as its most international. The Monash community includes more than 56,000 students and nearly 8000 staff across its eight campuses in Australia, Malaysia and South Africa and its centre in Italy. More than 19,000 international students from over 140 countries are enrolled at Monash University.

Monash admitted its first students in 1961 and quickly forged a place among Australia's leading research institutions. It ranks among the top 50 universities worldwide[1] and is a member of the Australia's research-intensive *Group of Eight* universities. Collectively, these eight universities produce more than 70 per cent of all basic research conducted in Australia's universities.

Monash University's largest campuses are located in Melbourne, in the south-east business and innovation zone, where 40 per cent of the state of Victoria's manufacturing activities take place. Monash is home to a major biomedical research precinct, the world's largest robotic crystallisation facility, one of the world's most powerful electron microscopes, and the nation's major wind tunnel facility. The Monash campus at Clayton is co-located with the Australian Synchrotron, the Melbourne Centre for Nanofabrication and next to the largest research and development site of the Commonwealth Scientific and Industrial Research Organisation (CSIRO).


The Ambassador of Portugal delivers a lecture at the Monash European and EU Centre.

The Australian Regenerative Medicine Institute is one of several highly regarded medical research centres within the biotechnology precinct. Its scientists focus on



The Monash Centre for Electron Microscopy, home to a suite of advanced instrumentation that can determine the composition, structure and bonding of materials down to the atomic scale.

## THE MONASH EUROPEAN AND EU CENTRE (MEEUC)

Established in 2006 with the support of the European Commission, this multi-disciplinary centre draws upon the expertise of the Monash faculties of Arts, Law, and Business and Economics, together with partner universities in the Asia-Pacific and Europe. The Centre conducts teaching, research and outreach activities that aim to develop and disseminate knowledge and expertise on the EU.

MEEUC offers study programs up to PhD level. Drawing upon the expertise of staff across and beyond MEEUC's three contributing faculties, MEEUC's flagship interdisciplinary **Master in European and International Studies** program considers Europe and the EU from political, legal, economic, social, humanitarian, environmental and security standpoints.

Current research projects include energy and the environment, EU external relations and climate change, transatlantic relations, and Islam in Europe. Regular visits by guest lecturers and researchers from Europe and other EU-related research centres worldwide contribute to a lively and intellectually stimulating environment for students and staff. Centre Director Professor Pascaline Winand holds a Jean Monnet Chair in European Integration, and the Centre is a member of an Asia-Pacific consortium of European centres of excellence for the study of Europe and the EU.

Students enrolled in MEEUC have access to an internship program in Brussels, and to other study opportunities in Europe through the Monash University Prato Centre and the University's network of European partners.

http://www.monash.edu.au/europecentre/

Monash is home to a major zebrafish facility, used for modelling a variety of human diseases and conditions.

## WORLD-RENOWNED RESEARCH AT MONASH

- Pioneering IVF technology
- Drug development including combating malaria and influenza
- Helping reduce the road toll through ground-breaking accident research
- Urban water supply and stormwater management
- Climate change
- Stem-cell research and regenerative medicine
- Obesity prevention and treatment
- Green chemistry for cleaner, more efficient and less hazardous manufacturing
- Counter-terrorism and community policing
- E-research
- Materials science
- Global population movements

unravelling the basic mechanisms of the regenerative process, enabling doctors to one day prevent, halt and reverse damage to vital organs due to disease, injury or genetic conditions.

In 2009 Australia was named as the first associate member of the European Molecular Biology Laboratory (EMBL), the Australian base of which is housed within the Australian Regenerative Medicine Institute at Monash University. A key element of the EMBL model, which Monash has embraced, is the strategy of attracting and accelerating the careers of promising early career researchers.

Monash has more than 100 research centres, including 11 university-wide cross-disciplinary research institutes. The University pursues excellence in fundamental research and challenge-based research in themes of global significance such as sustainability, health and wellbeing, productivity and future industries, social inclusion and culture and heritage.

Monash researchers participate in a number of major European Commission facilitated projects, including several European Sixth and Seventh Framework Programme (FP6/FP7) projects in fields that include accident research and injury prevention, urban water supply management, aeronautics, biomedical research, nanotechnology and green chemistry.

Monash partners with a wide range of industry, government and philanthropic bodies, and conducts research in a diverse range of science and technology areas, from drug discovery, pharmacy and drug development, to social and accident research.

Monash is also home to highly rated teachers and researchers in business and economics, the humanities, design, education, social sciences and law. The Centre of Policy Studies at Monash, for example, has provided expert economic modelling to the Australian and US governments, as well as to the World Bank and many major companies.

Major industry and research partners for the university currently include Pfizer, Merck Sharp and Dohme (Australia), Siemens, GlaxoSmithKline, IBM, Rio Tinto and BHP.

Monash is a member of the **M8 Alliance**, a Europe-based coalition of leading international medical schools that includes Charité-Universitätsmedizin Berlin, the Université Paris Descartes, Imperial College London, Kyoto University, Peking Union Medical College and Hospital, the Russian Academy of Medical Sciences and Johns Hopkins University.

*For further information about Monash research, education and expertise see* www.monash.edu

Footnotes
[1] Times Higher Education Supplement 2009.

Meeting at the Monash University Prato Centre.

## A BASE IN EUROPE

Monash University opened a Centre in Prato, Italy in 2001 as part of a vigorous program of internationalisation that saw the University also establish campuses in Malaysia and South Africa. The Centre provides Monash with a European base from which it pursues innovative educational and research programs with partners from Europe. The Centre's location within the medieval city of Prato provides an immersive teaching space to enrich programs in fine arts, archaeology, law, Italian, sociology, political science, European studies, and medieval and renaissance history.

The Monash University Prato Centre also provides a valuable platform for Monash researchers to convene workshops with major international research networks, as it is within close reach of the research powerhouses of Europe and the east coast of the United States. Major European consortia have met at the Monash University Prato Centre to explore areas as diverse as accident research, migration and social inclusion, nanoacoustics, Italian studies and medieval history. From Prato, Monash works actively both with local partners such as the Province of Prato and the University of Florence, as well as other international centres located nearby, including *Villa/Tatti* – the Harvard University Center for Italian Renaissance Studies.

http://www.ita.monash.edu/

# The University of Melbourne has a rich history of pioneering research.

The University of Melbourne is a dynamic research-driven community with over 46,000 students, including more than 12,200 international students from 129 countries, who are enrolled in courses across a range of faculties and graduate schools.

Committed to excellence in research, research training, teaching and learning and global engagement, Melbourne is a leading Australian university, with research expenditure second only to that of the CSIRO, and the largest cohort of research students in Australia.

The University has been host to many of Australia's, and some of the world's most distinguished medical researchers, including recipients of the Nobel Prize for Medicine. Further, it has acted as the point of nucleation for a remarkable array of associated medical research institutes and hospitals.

Melbourne is strategically located in one of the world's premier sites for biomedical research – the Parkville Strip. The sheer quantity of life-sciences research facilities, institutes, researchers, Fellows and postgraduate students in the Parkville Precinct and surrounds, and the comprehensive breadth of bioscience disciplines, is without parallel in the southern hemisphere and one of the very few such concentrations of research excellence worldwide.

## National Performance

The University has consistently ranked first or second on all major national research indicators of income, publications, research higher degree (RHD) load and RHD completions since 1996. These indicators are used by the Federal Government's Department of Innovation, Industry, Science and Research (DIISR) to allocate government funding for research and research training infrastructure. In 2009 (according to the latest data available) the University achieved the outstanding outcome of being ranked first for all parameters. The University also maintained its number one ranking for Australian Competitive Grants (ACGs).

## Research Highlights

The University has a rich history of pioneering research and technological development, remaining at the forefront of innovation. Highlights include:

- The Bionic Ear in the 1970s, bringing hearing to profoundly deaf children and adults. The bionic ear replaces the function of the ear by electrically stimulating the hearing nerve and providing sufficient hearing for recipients to understand speech.
- The Bionic Eye – a project led by the University of Melbourne, which will result in the improvement of

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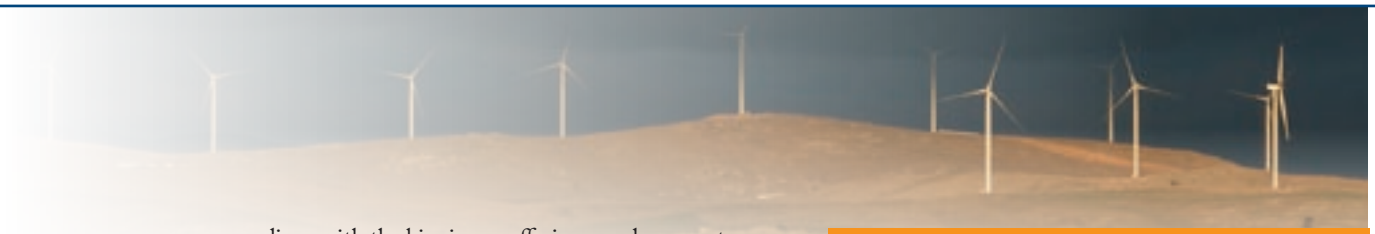


many lives, with the bionic eye offering a real prospect restoring useful vision to people with advanced retinal disease.

- HIV vaccine research that has attracted $4 million in funding from the US National Institutes of Health.
- The vaccine set to eradicate a fatal brain parasite, which has attracted $15.7 million in funding from the British Government and the Gates Foundation.
- The massive 96-million pixel OptiPortal, a powerful next-generation visualisation wall, the largest of its kind in Australia. The OptiPortal allows the user to view a number of images simultaneously and to visualise images in 3D. The facility also makes real-time communication possible with other researchers anywhere on the globe, and allows all parties to view the same data simultaneously.

## European Collaboration

The University of Melbourne has a wide range of research collaboration with European universities and research institutes, with almost 100 agreements for academic cooperation and exchange with leading European institutions.

Melbourne currently participates in five FP7 programs, including a multilateral project to fund the development of a plan to reform the Intellectual Property Rights (IPR) system.

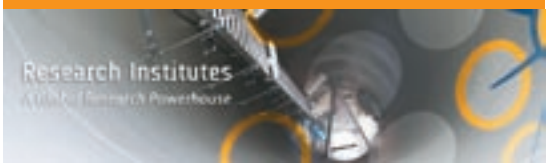
The University of Melbourne's Centre for Applied Philosophy and Public Ethics (CAPPE) is part of the IPR group that develops an optional supplement to the global IPR system. The Health Impact Fund is designed to address two fundamental problems. First, the poor in developing countries cannot afford existing medicines, which are under patent protection, due to the high mark-ups. Second, diseases of the poor attract little or no attention from pharmaceutical companies as even an effective and fully licensed product would not be able to earn significant returns. In this regard, current incentives for pharmaceutical innovators are skewed towards lifestyle diseases of the rich rather than reducing the global burden of disease.

The role of the Melbourne group, led by Professor Peter Singer is to provide ethical and prudential justifications for the Health Impact Fund.

Professor Singer is known worldwide for his engagement on behalf of the global poor.

**Recognising that multi-disciplinary institutes are an important means by which the University can harness its research breadth to meet society's contemporary challenges, the University has established five new institutes with proposals for other institutes now well advanced. The new institutes are:**

- **The Institute for a Broadband-Enabled Society: the first cross-disciplinary research institute in Australia dedicated to products, services and innovations that maximise the benefit of new broadband technologies to society.**
- **The Melbourne Brain Institute, which will be responsible for enhancing interdisciplinarity in neuroscience through stewardship of cross-faculty activities and providing an international neuroscience research-based focus.**
- **The Melbourne Energy Institute, which will provide international leadership in energy research and deliver solutions to meet future energy needs.**
- **The Melbourne Materials Institute, which will investigate materials from the quantum level, to practical devices for the benefit of society.**
- **The Melbourne Sustainable Society Institute, which will advance the goal of a sustainable society in Australia and the Asia-Pacific region.**




In addition to academic partners from the United Kingdom, France, Norway, the Netherlands, and the Philippines, the project involves policy groups from today's biggest emerging economies: China and India.

**www.researchinstitutes.melbourne.edu**

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# Stronger focus on international applied research

Recent science policy development in Australia has largely focused on how to get a better alignment between the fundamental research being undertaken in Australian science laboratories. This seeks to bring the processes of innovation necessary to deliver greater productivity in Australian industry, and, by implication, sustained economic success. This was the subject not only of *Powering Ideas*, the Federal Government's response to the national review of innovation in Australia, but also of an inquiry initiated in 2009 into improving knowledge sharing between governments, institutions and researchers.

The new European Union (EU) Centre at RMIT University Melbourne, brings together the capacity to link RMIT's established commitment to industry engagement and its strong linkages with European researchers, with a broader framework of partnership with the European Union countries and their universities and researchers. As the 'working man's college', RMIT has always been focused on knowledge and skills formation, which is relevant to and supportive of industry development.

In recent years, a careful analysis of alumni and existing research collaborations has led RMIT to focus on five key industry sectors: aviation; automotive; media and communications; building; and health and community services. Through a mix of industry forums involving industry, RMIT research leaders and client relationship systems, specific areas of industry needs have been identified and new projects developed. Work-integrated learning has become a core component of all award programs, including postgraduate and vocational education and training.

RIGHT: RMIT graduate Jason Seris is the first Australian chosen for Rolls-Royce's North American leadership development program. *Photo by: Carla Gottgens*


BELOW: The Formula Hydrogen project, a collaboration between RMIT and Germany's Fachhochschule Ingolstadt University of Applied Sciences, was designed to produce a demonstration vehicle using cutting-edge sustainable automotive technologies.

These features of academic activity can be found already at RMIT. There are four research institutes in Design, Global Cities, Platform Technologies and Health, together with research centres such as the Sir Lawrence Wackett Centre for Aerospace Design Technology, the Spatial Information Architecture Laboratory, the Centre for Design, the Australian Housing and the Urban Research Institute. All of these have strong relationships with both industry and European research colleagues.

Exciting developments are occurring in automotive engineering with RMIT participating in the sophisticated design of high performance racing cars, including the use of alternative racing technologies (e.g. solar, hydrogen, electric). This has been accompanied by impressive progression in energy conservation and renewable energy technologies in collaboration with leading vehicle manufacturers and suppliers in Australia and overseas.

Students are able to participate in these relationships through various exchange and study tour opportunities. Perhaps the most exciting of these is the RMIT International Industry Education Research Program (RIIERP), which offers students an opportunity to work in a European company for six months. Initially focused on postgraduate engineering students, this program is now available to undergraduate students.

The new EU Centre will support all of these existing activities and play an active role in extending the collaboration among Australian researchers (not only those at RMIT) and industry, and their counterparts in Europe. A key focus will be the sharing of information, not only through newsletters and a website, but also through briefings for government and industry leaders. Beyond this, the EU Centre will build partnerships to address key strategic issues for government and business, in accord with the major commitments in the *Europe-Australia Partnership Framework* which was developed in 2008 through discussions between the European Union and the Australian Government. The major challenges of climate change, energy and security and science, research and innovation will feature prominently. Within RMIT, each of the academic areas will be encouraged to draw on the Centre's networks to enhance their scientific collaborations to identify new resources to support projects, and to develop closer relationships with European audiences for their work.

www.rmit.edu.au

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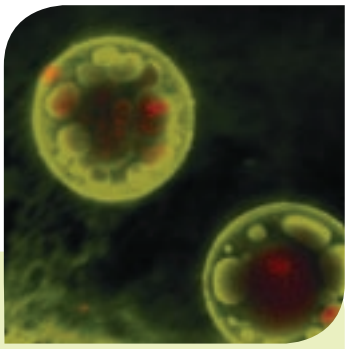
MEMBER

# University of Adelaide Research Collaborations



The University of Adelaide has an outstanding track record and is recognised as an Australian leader in research excellence, committed to delivering the highest quality research outcomes.

The University has established five world-class research institutes in partnership with government and industry. These Institutes bring together world-leading researchers, supported by modern infrastructure and an innovative culture, to tackle national and international research priorities. The multi-disciplinary focus of The University of Adelaide's Research Institutes provides an ideal platform for international research partnerships.

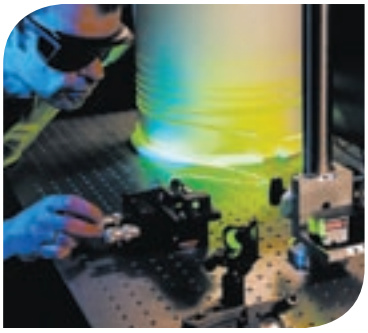
In the past year, the University of Adelaide signed a number of international agreements with overseas institutions including France and the UK and is an active participant in the Academic Consortium 21 (AC21). University staff meet with partner institutions and governments around the world, resulting in visits by partner institutions from 11 countries to explore collaborative opportunities, especially in the sciences.

The University's staff have extensive links with international research colleagues, which have resulted in large numbers of joint research grants and co-publications. Germany and the UK are two of the top countries for international research collaborations, which contribute to the University's global reputation and ranking on both the QS-THE and SJTU systems in 2009.

Significant international collaborations include:

- The French Human Frontiers Scientific Program Organisation for research with the Netherlands and USA partners on the quantitative analysis of DNA;
- Research collaboration with partners in Puglia, Italy, funded by the South Australian and Apulian governments.
- The Institute for Photonics and Sensing (IPAS) is collaborating with DTU Fotoniks, Technical University of Denmark on the production of microstructured optical fibres and with Optoelectronics Research Centre (ORC) at University of Southampton on the development of non-linear optical fibres.
- Bioplogist Dr Malgorzata Kotula-Balak from Poland was awarded a Go8 European Fellowships for early career researchers from emerging European economies to work at the University of Adelaide.
- A/Prof. Metha has been awarded a prestigious DAAD scholarship to conduct research in Germany at the Technical University of Munich, performing laser spectroscopy experiments on gold clusters deposited on ceria surfaces.

For further information www.adelaide.edu.au/research



The University of Adelaide undertakes international collaboration in the quantitative analysis of DNA (left) and the production of microstructured optical fibres (above).

## SCOPE FOR HEALTH IN PREGNANCY

Associate Professor Claire Roberts from the Robinson Institute and Professor Gus Dekker from the Discipline of Obstetrics and Gynaecology at the Lyell McEwin Hospital, are leading the way to developing predictive tests for first time mothers to provide personalised and accurate risk ratings for individual pregnancy complications such as preeclampsia and pre-term birth.

The SCOPE project is part of an ambitious international collaborative effort with researchers from the University of Adelaide, New Zealand, Ireland and the UK. With 4000 women now recruited, SCOPE aims to develop predictive tests for pregnancy complications that affect over 1 million mothers and their babies worldwide.

SCOPE aims to revolutionise pregnancy management with this integrated international collaboration optimising the chance of successfully identifying diagnostic markers and developing highly accurate screening tests to predict a couple's risk of developing the three main pregnancy complications before symptoms develop.

For further information about SCOPE go to www.scopestudy.net

# The INNOVATION DIMENSION
## exploiting geographical synergies

Mark Matthews, Kerrie Glennie and Jean-Francois Desvignes-Hicks – FEAST

Vines growing in the Domaine Chandon vineyard in the Yarra Valley face many of the same challenges from disease, adverse weather and climate change as their European counterparts. *Photo by Henry Burrows.*

The vineyards of Chevalier-Montrachet, Montrachet, and Batard-Montrachet in Puligny-Montrachet, Burgundy, France. *Photo by Jonathan Caves.*

### QUEENSLAND'S GROWING NETWORK OF PARTNERS

In Queensland, the State government and research agencies work with universities, the Australian Institute of Marine Science (AIMS) and the Commonwealth Scientific and Industrial Research Organization (CSIRO) to identify international and sub-national key alliances. Given the vulnerability to climate change of Queensland's environment and economy, attention is directed towards climate change adaptation networks and co-investment in targeted projects, notably with partners in the UK and China. Queensland's tropical expertise is a driver in engagements with India's agricultural and medical biotechnology sectors and with organisations that support primary industries in South East Asia and the Pacific region. Synergies are also growing with European partners, in France, Germany and Italy. These benefit from the sharing of expertise in managing and exploiting Queensland's natural resources, at the same time strengthening associated enabling technologies that are emerging.

Europe and Australia both possess great geographical diversity. Some of these geographical circumstances differ dramatically, for example Australia has large tropical areas whereas Europe has none. Other geographical circumstances are very similar, such as the relatively arid but agriculturally significant Mediterranean regions and similar conditions in South Australia and south-eastern Western Australia.

This geographical diversity has particular significance for European-Australian research cooperation, especially in regard to the role of state/territory governments in Australia and their relationships with particular Member States. Existing bilateral relationships at the sub-national level in Australia and Member State level in Europe are vibrant and growing in importance. For example, a number of state governments have been developing webs of bilateral cooperative links designed to exploit geographical circumstances.

There is also the potential to develop new multilateral relationships based around shared geographical circumstances – such as adapting to climate change in Mediterranean conditions (southern Europe and South Australia may become more arid with climate change).

These geographical synergies are particularly relevant to business-academic cooperation at the SME level. Many SMEs are founded, and prosper, on the basis of distinctive geographical circumstances, notably in the food and fibre sectors. This means that the cooperative links between local universities, research institutes/agencies and SMEs can be centered upon these geographically specific factors to comparative advantage. This, in turn, means that there is significant scope for exploiting latent synergies between these regional clusters. Duplication in efforts can be reduced and complementarities strengthened by twinning geographically specific research.

Significantly however, exploiting these synergies is unlikely to be a major focus at EU and Federal Government level policy stances. Rather, the main drivers of such cooperation will more naturally

focus on specific regions within EU Member States and specific state and territory governments within Australia.

Given that FP7 has a strong focus on innovation (i.e. on industry-academic partnerships) this geographical dimension to European-Australian cooperation stands to play a major role in drawing SMEs into appropriate FP7 projects. The key enabler for such a strategy is more active Australian state and territory government engagement with FP7. FEAST is moving to facilitate this shift in emphasis by constructing a more effective distributed network of National Contact Points (NCPs) for FP7 focused around state/territory-based nodes at key universities. This distributed NCP network will be better positioned to work cooperatively with state and territory governments in engaging local SMEs with FP7 – often by exploiting shared geographical circumstances with Europe. To this end, the new distributed NCP network will nominate a specific NCP responsible for the SME activities of FP7. This FP7 modality is, at present, dramatically under-exploited.

The growing emphasis on supporting innovation at both the state/territory and Member State/national region levels opens up exciting new possibilities for stronger Australian engagement in the innovation-focused components of FP7. A key enabler for this new approach will be stronger cooperation between Australia's NCP network and state and territory governments. Each state and territory government in Australia with an active interest in supporting SME's innovation should ensure that it develops a strong working relationship with its new regional FP7 National Contact Points. ■

Nullamunjie Olive Grove in Tongio, in the east of the Australian state of Victoria. *Photo by: Fir0002/Flagstaffotos*

Olive trees in Cordoba, Spain. Like much of Australia, the rural landscapes of southern Europe are particularly fire prone.

## GEOGRAPHIC DIVERSITY – A COMMON CHALLENGE

Although Europe only covers seven per cent of the Earth's land surface (with over 10 million square kilometres compared with 7.7 million for Australia), the continent's geographic diversity is high and mirrors many of Australia's characteristics and associated challenges.

Italy, Greece and the UK have long coastlines to manage and protect and, perhaps surprisingly, France has the world's second largest Economic Exclusion Zone (EEZ) – the sea zone in which a coastal country has exclusive exploitation rights over marine resources – just ahead of Australia. Many of the challenges associated with the management of EEZs depend on the coastal interfaces and major rivers flowing through them. Waters from mighty rivers like the Danube or the Rhine have to cross many borders and jurisdictions and have diverse usages and users. Whether water surges from the mountainous slopes and hillsides in northern Europe or from near cyclonic events in the west, its scarcity makes the bushland and rural landscapes of southern Europe particularly fire prone. Indeed, climate change is not only apparent in arctic regions of Europe.

If it weren't for discounted airfares and an extensive network of high-speed land transport, many of Europe's rural communities would have become highly isolated. In contrast, European urban centres seem to be ever expanding with an increasingly mobile population. Migrations within and between European countries have become a common feature of European geography. Europe strives to build regional networks with partners such as Russia and various Mediterranean and North African countries in an attempt to find solutions to the pressing issues posed by illegal immigration or energy security. These extended networks add to the existing overlay by making the geographies in these arid and subtropical regions, their crops, droughts and other natural resources, part of the near-Europe geographic diversity.

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# UK – a strong ability to innovate

Excellent research is fundamentally important to the UK's aspirations for a world-class research base that delivers strong economic impact. UK Government funding for science research, through Research Councils and HE Funding Councils, will reach just under £6 billion by 2010/11. This will bring Government support for UK research to its highest-ever level, thus enabling the UK to maintain its leading position in research excellence, giving rise to greater exploitation, as well as helping to build a stronger economy.

Since 1997 the UK has invested over £3 billion to rebuild science infrastructure so that world class scientists have world class facilities across a broad range of research areas including health science, energy technologies, ICT, nano and biotechnology, materials and environmental science. This investment has significantly strengthened the UK's ability to innovate, increasing its potential for research commercialisation. The funding has created a critical mass of professional capacity in the knowledge transfer sector, which will put research funding on a financially sustainable footing in the future.

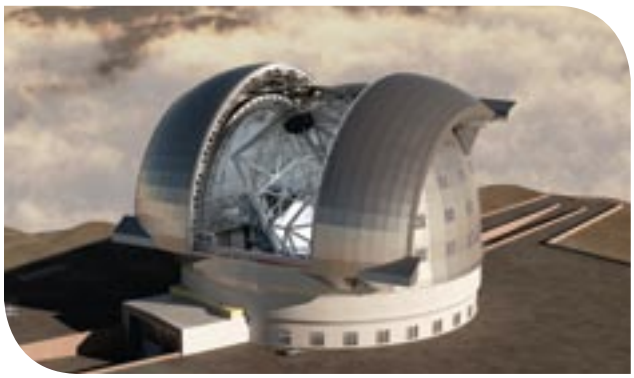
> "the UK is among the world's top research nations, but its research base can only thrive if it engages with the best minds, organisations and facilities wherever they are placed in the world"

The UK is among the world's top research nations, but its research base can only thrive if it engages with the best minds, organisations and facilities wherever they are placed in the world. As such, the UK research and innovation system places large value on collaborations between other nations, enabling them to capitalise on the strength and knowledge of others, while maintaining their own solid place in global science. In recent years, the UK has consolidated its position as Europe's top R&D location and it is the number one recipient of R&D investment in Europe.

## UK-Australia collaboration in science and technology

In recent years, there has been a significant increase in the number of new collaborations between the UK and Australia, going from 7.3 per cent in 1999-2003 to 8.6 per cent in 2004-2008. This was largely due to ease of collaboration, increased research investment and the increase in funding opportunities both in the UK and Australia. The main areas of collaboration are in biological science and agricultural, environmental and physical sciences. However, linkages in the emerging science areas, including nanotechnology, are also increasing.

The relationship between the Queensland Climate Change Centre of Excellence (QCCCE) and the UK Met Office Hadley Centre for Climate Change and the Walker Institute for Climate System Research is one example of successful collaboration between UK and Australian scientific bodies. Since March 2007, the three organisations have been collaborating on the science of climate systems and developing the modelling needed to study the effects of climate change. Due to their success in late 2009, these organisations expanded their agreement to involve a Queensland-UK Climate Science Fellowship program. Under this program, four scientists from the Met Office Hadley Centre will visit Queensland for up to six months over the next two years to work on Queensland-focused climate science research projects. In return, Queensland scientists will also work at the Met Office Hadley Centre in Exeter.



A concept drawing of the European Extremely Large Telescope (E-ELT), a project from the European Southern Observatory. The observatory is accessed by one of the many Research Councils in the UK. The UK is playing a leading role in the E-ELT, leading the generation of the science requirements, developing instrument designs and adaptive optics technologies, designing telescope systems through industrial contracts and developing manufacturing processes for the optical elements. *Photo by: Swinburne Astronomy Productions/ESO.*

The strength of UK-Australia's joint research is also very prominent in astronomy. The Anglo-Australian Observatory and Telescope was set up under a bilateral agreement between the UK and Australia in 1973. A supplementary agreement was signed in November 2005, extending the agreement until July 2010. This 35 year collaboration with the UK is a great example of how international cooperation between governments, institutions and researchers can achieve ground-breaking results.

Examples such as these are not a rarity and they are becoming increasingly more common between the UK and Australia. By capitalising on each other's resources and research strengths, the two countries benefit mutually from such collaboration.

*Ms Lindsay Morgan, Science and Innovation Officer, British High Commission, Canberra.* http://ukinaustralia.fco.gov.uk/

# France – bringing research to the fore of innovation

One of the main objectives of the Embassy of France is to facilitate and strengthen the scientific and technological cooperation between Australia and France. Today, thanks to various programs supporting French and Australian postgraduate students, postdoctoral and senior researchers in all fields of science, and especially the French-Australian Science and Technology (FAST) program, the collaborations between our two countries are of an exceptional standard and cover a large number of areas.

The Embassy of France is currently working in connection with the Australian Academy of Science and the Department of Innovation, Industry, Science and Research to map out the future of French-Australian cooperation given that FAST, the key program for our cooperation, will end in 2011.

French-Australian cooperation should focus on priorities, foster exchanges of excellence, reduce the gap between research and industry and emphasise innovation. By focusing on priority themes, we intend to better structure the cooperation and improve the communication between players in order to achieve better outcomes. By reducing the gap between research and industry, we intend to foster research at the forefront of innovation.

> by reducing the gap between research and industry, we intend to foster research at the forefront of innovation

Various meetings and discussions with Australian partners have identified areas of common interest and priorities – such as environment and climate change, energy and energy efficiency, health and medicine, biotechnology, just to list a few areas of importance.

Two main themes, *Biotechnology and Sustainable Management of the Coral Sea*, were chosen to be the core actions of the French Embassy. The objective is to set up and develop strong events and programs around these themes, bringing together major Australian and French actors: government organisations, funding agencies, research centres, universities, learned academies, associations and businesses.

Among the French actors, the French Embassy would like to involve the Innovative French Clusters. These Clusters could play an important role within French-Australian cooperation and act as a gateway to strengthen our partnership. The French Clusters are very attractive for a few different reasons: they bring together businesses, educational institutions and public and private research laboratories to collaborate and develop synergies on world-class R&D projects of international renown. They are working on research projects at the forefront of innovation, composed of networks of companies and researchers, with access to innovative platforms and top-notch dedicated services, benefiting from advantageous financial support.

Whitsunday Islands, Queensland, Australia : This scene is dominated by the largest island and namesake of the chain. Deep green forest covers most of Whitsunday Island, which is outlined by brilliant white sand beaches, the largest and most dramatic being Whitehaven Beach at the south-eastern end of the island. On Hamilton Island, the strong linear feature at the southern end shows where a jet-accessible runway was added to allow airlines from major Australian cities to fly directly to the islands. The swirls of pale blue around the islands show a mix of sandy bottom waters and shallow, fringing coral reefs. The green land in the south-western corner of the image is a small section of Conway Ranges National Park, on the shoreline of mainland Queensland. *Photo by: NASA Earth Observatory.*

The French Embassy, with its Australian partners, is working to offer new opportunities towards a cooperation of excellence. The two actions, *Biotechnology and Sustainable Management of the Coral Sea*, are two new possibilities offered to researchers and scientists from both countries to work together and produce the best results. We invite all of you, who are interested in French-Australian cooperation, to intently examine these opportunities, with the French Embassy remaining at your disposal to provide the necessary information.

*Dr Kaddour Raissi, Attaché for Science and Technology, Embassy of France in Australia*

# Germany – a global research destination

View of the DFG office in Bonn. *Photo by: German Research Foundation (Deutsche Forschungsgemeinschaft – DFG)*

Germany spends some 2.6 per cent of its GDP on research and development (~€66 billion in 2008), with one third coming from the public sector and the rest from the private sector. Germany has a well-developed and diverse research landscape that produces roughly 9 per cent of the worldwide knowledge.

Germany boasts more than 100 research universities, as well as four major public research institutions:

- The Max Planck Society (MPG), with some 76 institutes, specialises in excellent basic research;
- the 16 institutes of the Helmholtz Association (HGF), focus on mission-oriented research;
- the Fraunhofer Society (FhG), with 59 institutes nationally and an increasing number of locations abroad, specialises in applied and contract research, and;
- the Leibniz Association (WGL) has 86 institutes that conduct topic-oriented research in humanities, social sciences, science and mathematics.

The private and public sector also work closely together in about 100 so-called networks of competence (www.kompetenznetze.de).

Science and technology cooperation between Germany and Australia has developed significantly since the signature of the STC agreement in 1976. It gained new momentum in 2010 when a scientific delegation, led by the German Federal Ministry of Education and Research (BMBF), visited Australia to explore cooperation potentials in photovoltaics. Despite the language barrier a recent bibliometric study found that in terms of co-publications Germany ranks 3rd after the United States and the UK.

As a result of the 2010 visit, the BMBF and the Department of Innovation, Industry, Science & Research (DIISR) have jointly launched two calls for proposals in areas of mutual interest (photovoltaics, environment, geo- and marine sciences, nanotechnologies, ICT), resulting in more than 90 applications.

Besides the International Bureau of the BMBF, there are three major German agencies supporting bilateral cooperation with Australia:

The German Academic Exchange Service (DAAD), supports international exchanges of students, academics and researchers. In 2008, it funded about 600 exchanges all together from Germany to Australia and vice-versa at a cost of almost €3m. So far, more than 2000 Australians have received DAAD funding. With the help of the DAAD Information Centre in Sydney, these alumni are currently establishing an Australian DAAD Alumni Association. In March 2010 the DAAD organised a national alumni meeting with 168 DAAD and Humboldt alumni and a delegation from Germany. On this occasion, the Group of Eight (Go8) and the DAAD renewed their firmly established links through a new Memorandum of Understanding (MoU) focused on research collaboration, enhancing an initial scheme that has already provided over A$3m to support research exchanges between the two countries.

One of the most important aims of the German Research Foundation (Deutsche Forschungsgemeinschaft – DFG) is to promote young scientists and scholars. As the "central institute of self-administration for science", the DFG provides sustainable support for young researchers, addresses the interdisciplinarisation of the sciences and humanities and supports networking in research. The DFG has MoUs with the Australian Research Council (ARC) and the Australian National Health and Medical Research Council (NHMRC).

Since 1953 the Alexander von Humboldt Foundation (AvH) has awarded more than 460 fellowships to young postdoctoral scientists and scholars from Australia to spend a long-term research stay at a German research institution. More than 60 internationally recognised Australian scientists and scholars have been awarded an AvH research award. Since the inception of the Feodor Lynen fellowship program, the AvH has provided the opportunity for more than 90 young German postdoctoral fellows to spend a research stay ranging from one year to four years duration at an Australian research institution. Alumni may join the Australian Association of von Humboldt Fellows (www.humboldtaustralia.org.au).

The central refrigeration plant supplying HERA's proton ring with liquid helium. (Source: DESY in Hamburg). *Photo by: DESY in Hamburg, Helmholtz association, DESY - Deutsches Elektronen-Synchrotron.*

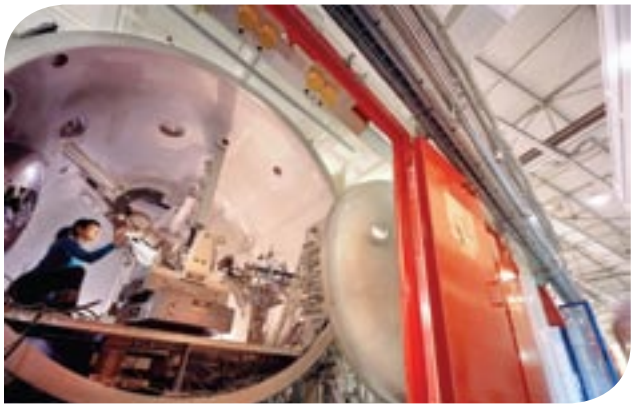
This test facility, the TESLA technology was developed and tested. *Photo by: DESY in Hamburg, Helmholtz association, DESY - Deutsches Elektronen-Synchrotron.*

*Dr Hans-Jörg Stähle*
*International Bureau of the Federal Ministry of Education and Research*

*Dr Andreas Jaeger*
*Director of Information, Centre of the German Academic Exchange Service*

# Italy-Australia collaboration in science and technology

The funding for the national science and innovation system in Italy is divided in almost equal proportions between the private and public sectors. The key public performers are the universities (of which there are 65 public as well as an additional 12 private institutions), the National Research Council (Consiglio Nazionale delle Ricerche) and other organizations such as the Italian Space Agency (Agenzia Spaziale Italiana) and Agency for Alternative Energy (Ente Nazionale per Energie Alternative). The activities of the private sector, principally in the manufacturing sector, are coordinated by the Italian Industrial Association (Confindustria). Italy's science and innovation sectors, both public and private, have a strong and key participation in large scale and significant international science collaborations such as CERN (the European Organization for Nuclear Research), EMBL (European Molecular Biology Laboratory), ESRF (European Synchrotron Radiation Facility), ESA (European Space Agency), ESO (European Southern Laboratory) and ISS (International Space Station). Priority areas, as laid out in the National Research Program for 2009-2013, include alternative energy sources, agriculture, environment, state-of-the-art products emanating from the manufacturing industry, cultural heritage, development of technologies for energy efficient modes of transport and aerospace.



ABOVE: Preparation of an experiment in a vacuum tank on ESRF beamline ID01 for anomalous scattering studies *Photo by: P. Ginter/ESRF.*

LEFT: Aerial view of ESRF. *Photo by: A. Petricola, AIR ISERE, ESRF.*

BELOW LEFT: Putting a sample on a beamline. *Photo by: G. Duvernay, INSIGN STUDIO, ESRF.*

BELOW: In the ESRF experimental hall: first hutch of BM32 and storage ring. *Photo by: P. Ginter/ESRF.*

The priority Italian national research themes appear to match many of those which are of pertinence to Australia's national science and innovation program. Collaboration between Italy and Australia in science has been laid out in official protocol agreements signed in 1993 and updated in 2002. Italian scientists actively collaborate with their Australian counterparts in many areas which are of common interest. Cooperation between Italy and Australia in the university sector is particularly active and rich. This is reflected in the numerous official cooperation agreements that presently exist between Italian and Australian universities – there are 114 agreements between a total of 38 Italian and 28 Australian universities. The cooperation covers a vast range of the natural and social sciences, as well as the humanities. The existing protocols and MOU's specifically cover mobility of students and researchers and research exchange programs. There are also now in place recently signed specific protocols covering collaboration in large scale, cutting-edge projects, such as the ambitious radio astronomy known as the Square Kilometer Array, as well as each nations' respective synchrotron radiation sources, ELETTRA (Trieste, Italy) and the Australian Synchrotron (Melbourne, Australia). It can be anticipated that similar protocols may eventually be extended to other areas such as those involving space science, advanced renewable energy technologies and climate change science. In this regard, an important function of the Office of the Scientific Attaché, Embassy of Italy in Canberra, is to promote collaboration via the organization of bilateral workshops. Many of these have been held in the recent past and others are now in the planning stage.

*Professor Oscar Moze, Scientific Attaché, Embassy of Italy, Canberra*

# The Swiss Australian Academic Network (SAAN)

Australia and Switzerland are global players in science and technology and make an above average contribution relative to the size of their population. Similarly, Australia and Switzerland maintain strong economic links, with Switzerland's influx of global direct investment into Australia in 2009 ranking second among European countries and sixth globally. Both countries maintain world-class academic institutions of excellence, with several of their universities found among the global top-100 lists, and each country accounts for many Nobel Laureates. However, current bilateral arrangements are limited to a few agreements between individual Australian and Swiss universities, publicly and privately-funded research institutes and government agencies. Accordingly, there is a need and opportunity to expand and strengthen the reciprocal academic exchange between the two countries on all levels.

The Swiss Australian Academic Network (SAAN), created as an open and highly interactive "grass-roots" organisation, is committed to identify, develop and improve networking opportunities between Swiss and Australian academics. This will assist in expanding collaborative research, increasing bilateral exchanges and lobbying government and industry in the two countries. SAAN aims to reciprocally raise awareness and profile of Australia and Switzerland throughout the academic, industrial and business sectors covering life sciences, engineering, humanities and the arts. SAAN has a track record of organising regular events and lectures that directly link industry, academia and other stakeholders, and SAAN has made a submission on this subject to the House of Representatives Standing Committee on Industry, Science and Innovation.

SAAN is seeking to establish and maintain connections between leading academics in Australia and Switzerland, and hosts events and lectures to facilitate, expand and nurture strong ties within academia, as well as to provide linking opportunities with industry. SAAN's current focus projects include:

- Actively promoting the establishing of a bilateral agreement between the major Swiss universities and the Group of Eight (Go8) leading universities in Australia to establish and resource short-term exchange programs for postgraduate academics.
- Facilitating the creation of dedicated fellowships for the exchange of students and postdoctoral fellows between the two countries.
- Increasing the representation of SAAN in Switzerland.
- Extending communication among SAAN members and to add further value to its members through the expansion of the SAAN website (www.saan.id.au) and monitoring existing collaborations and programs between Australian and Swiss academics, as well as other stakeholders.

SAAN is a not-for-profit organisation, incorporated as a company limited by guarantee and is promoted by the Embassy of Switzerland in Canberra, the Consulate-General of Switzerland in Sydney, the Australian Embassy for Switzerland in Berlin, the Swiss Australian Chamber of Commerce and Industry (SACCI) and SWISSNEX in Singapore. SAAN proudly acknowledges existing corporate sponsorship arrangements with industrial partners to pursue its missions.

Since its inception, originally as the Swiss Academic Network Melbourne in 2004, SAAN is now a national organization that has been growing steadily and today has a membership base in excess of 250 individuals, with approximately 200 residing in Australia and 50 in Switzerland. SAAN members comprise scientists, physicians, lawyers and other leaders from academia, industry and commerce. SAAN has representatives and promotes activities in Switzerland and in all Australian States and Territories. Since SAAN strives to act as a resource hub across all professional sectors, membership is open to academics working in Australia or Switzerland and is free of charge.

*Associate Professor Matthias Ernst, SAAN*

> "there is a need and opportunity to expand and strengthen the reciprocal academic exchange between the two countries on all levels"

# NEW ZEALAND
# GATEWAY TO ASIA AND THE PACIFIC ISLANDS

John Larkindale
High Commissioner
New Zealand High Commission

Science and innovation are key elements of the New Zealand Government's economic agenda. Our Prime Minister recently said that New Zealand's future economic performance depends to a large extent on generating and using new ideas. As a former scientist myself, I whole-heartedly agree. International science connections, and in particular the way we leverage them, play a big part in shaping the success of our science and innovation.

Our international science engagement is underpinned by three key principles: first, to establish strong relationships with partners able to contribute to building, expanding or enhancing New Zealand's science capabilities and create economic or other forms of value; secondly, to contribute to creating solutions to global challenges; and finally, to contribute to New Zealand's wider diplomatic objectives.

Effective international science connections extend our science capabilities and create opportunities for technology transfer. They ensure our scientific community can share data, expertise and knowledge and contribute to finding scientific solutions to global challenges, for example, pandemics, biosecurity and climate change.

Science connections are also an important strand in our bilateral relationships. New Zealand's international science connections with Europe are discussed in contributions to this publication, but an area that also deserves special attention is our engagement with Asian and Pacific Island neighbours.

In Asia, our science relationships with Japan, China and Korea have been enhanced by signing bilateral science and technology cooperation agreements. Programs with Japan are diverse and have included bilateral work in areas such as biotechnology, functional food, immunology, nanotechnology, natural hazards and agriculture. New Zealand's RS&T connections with China are focused in four priority areas: Food (particularly biotechnology), Health and Biomedical Sciences, Environmental Science and High Technology Platforms (including nanotechnology and superconductivity). Deploying science products in the marketplace, and thereby directly linking scientific research to economic growth, is of increased interest and attention. With Korea, areas of interest include biotechnology, ICT, renewable energy and materials science. Collaborations in the Antarctic area are also growing.

The New Zealand Government is also supporting the development of research linkages with Taiwan, Singapore, Vietnam and India.

New Zealand has a special and close relationship with Pacific Island nations, and, along with Australia, is a major contributor to development in the region. Our contribution reflects the role that research, science and technology can play in supporting economic growth and reducing poverty. For example, New Zealand science providers are working in the Pacific on areas including biosecurity, human health, information technology, climate change and geothermal energy. We work alongside the EU as a partner in the Framework 7 Pacific-EU Network for Science and Technology (PACE-NET) project, and we have supported regional organisations that undertake scientific work across the Pacific.

Looking to the future, I expect to see New Zealand's international science connections continue to broaden beyond the realm of science-focused goals to play a greater role supporting strategic economic and diplomatic objectives, and contributing to solutions to global challenges. I welcome the contribution of FEAST and of this publication in supporting international science connections between Europe, Australia and New Zealand. ■

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# New Zealand research priorities and international connections

In May 2010 New Zealand's Prime Minister confirmed significant new Government investment in Research and Development, saying: "Science fits into the first of our economic objectives – lifting the long-term performance of the New Zealand economy. Knowledge drives prosperity … and the Government has a crucial role in ensuring that knowledge is developed and used to improve the living standards of all New Zealanders."

The Government has identified key priority outcome areas for New Zealand science. These areas are: high value manufacturing and services; biological industries; energy and minerals; hazards and infrastructure; environment; health and society. Government's future investment in research will increasingly focus on these areas.

By citation rankings[1], New Zealand has internationally-rated science capability in agriculture/biological sciences (ranked 16th in the world compared with our overall ranking of 32 across all research fields), social sciences (16); Earth and physical sciences (24); and environmental research (25, with the 3rd highest citation rate per paper).

Opportunities for international research collaboration are almost limitless – therefore, prioritisation of investment is critical. The Ministry of Research, Science and Technology (MoRST) has developed an International Linkages Strategy to guide its efforts to build and support the country's international research connectivity. The priority regions for MoRST effort are Europe, North America and North Asia. Specific countries have been identified as strategic partners according to the level of current engagement and the degree to which their fields of research excellence align with the Government's priority research topics.

## New Zealand research links with Europe

New Zealand has signed a Science and Technology Cooperation Agreement with the European Commission. This Agreement recognises the significant relationships that already exist – over 60 per cent of New Zealand researchers have an active collaboration with at least one Member State – and the potential for mutually beneficial collaboration. The Agreement provides for regular meetings between MoRST and the Commission to agree priority fields for, and mechanisms to support, research collaboration. The priority fields include: Food, Agriculture, Fisheries and Biotechnology; Environmental Science; Health; Information and Communications Technology research.

The International Strategy also focuses on links with three European research powerhouses – Germany, France and the UK. Germany is our fourth most significant science partner and we share a Science and Technology Cooperation Agreement. Collaboration areas for Germany, under the Agreement include: Health; Food, Agriculture, Biotechnology; Advanced Manufacturing; Environment (especially climate change); Marine and Antarctic Research; Renewable Energy.

France is also a significant research partner for New Zealand and there has been a long and productive history of collaboration. Priority collaboration areas for France (through the Dumont d'Urville joint travel grant scheme) include: Food, Agriculture and Fisheries; Biotechnology; Renewable Energy and Energy Efficiency; Biodiversity; Nanosciences.

The UK is one of New Zealand's most important research partners – about 30 per cent of New Zealand researchers have a UK collaborator. MoRST's effort focuses on encouraging linkages in the high technology sector, especially life sciences.

New Zealand also has strong research links with other EU Member States. For example, the Wageningen Research University in the Netherlands collaborates with many New Zealand research institutions. There are also notable science connections with Spain, Belgium and Italy. Switzerland, as a world leader in pharmaceutical and biomedical research has significant 'Kiwi' connections in these fields. The European Framework Programme (FP7) is an important vehicle for the engagement with these other EU Member States. ■

FOOTNOTE

1 SCImago (2007). SJR — SCImago Journal & Country Rank. Retrieved May 18, 2010, from http://www.scimagojr.com

Lake Benmore hydroelectric dam, New Zealand.

# FRENZ
## for the future of EU-NZ linkages

FRENZ (Facilitating Research cooperation between Europe and New Zealand) is a joint initiative between the New Zealand Ministry of Research, Science and Technology (MoRST) and the European Commission (EC) to enhance the engagement of the New Zealand research, science and technology community with the European Union's Framework Programme for Research and Technological Development (FP7).

The FRENZ platform seeks to provide the necessary information, guidance and support required to promote the effective participation of the New Zealand research community in FP7. The services FRENZ offers serve to facilitate and increase the quality, quantity, profile and impact of NZ-EU research cooperation under FP7 through the development and execution of a suite of activities to increase the awareness of opportunities for NZ engagement.

The FRENZ platform aims to:

- deliver relevant information on research cooperation opportunities through themed emails and web pages aimed at different research disciplines;
- provide high quality advice, guidance and training on all aspects of applying for and managing European Commission research projects;
- develop resources specifically designed to address NZ participation in European Commission research programmes;
- assist organisations in the development of strategies to increase their involvement in the Framework Programme.

For many New Zealand researchers, the inclusion of a period of work in Europe is common, with the expectation that such a stay will develop their international standing and the peer linkages required to support a career back in New Zealand. Whether expatriate researchers intend to return or not, MoRST wishes to build and maintain links with these researchers. FRENZ's research project, Diaspora, is conducting surveys and will be presented to the European Commission and MoRST in order to:

- stimulate policy dialogue;
- attempt to network more effectively with both the European and New Zealand research Diasporas and, in turn;
- enhance New Zealand-EU research collaboration.

Diaspora also looks at European researchers in New Zealand. The large number of European researchers conducting research abroad represents an untapped asset for European research. The European Commission is attempting to utilise this previously unrecognised resource by building and maintaining links with expatriate European researchers. Through the EURAXESS-Links project, the *EC* has developed a networking tool for European researchers based in the USA and Japan. It provides information about research in Europe, opportunities for research funding, international collaboration, trans-national mobility and European research policy.

The Network for European Researchers in New Zealand seeks to develop a complementary system addressing New Zealand-based European researchers. To achieve this, FRENZ is conducting a survey of eligible researchers, concerning their motivations for mobility and their personal experiences and perceptions of EU-New Zealand research, science and technology collaboration. The survey will establish a database of New Zealand-based European researchers, allowing the EURAXESS-Links project to establish links with these researchers by developing an online toolkit to advise on relevant opportunities and developments in the European and New Zealand research sectors. An outcome of this study will be a clearer picture of both the number and motivations for researcher mobility, and the opportunities for cooperation in areas of mutual interest. This analysis will be presented to the EC and *MoRST*, in order to stimulate policy dialogue with a view to the development of new joint activities. ■

> for many New Zealand researchers, a period of work in Europe is common, with the expectation that such a stay will develop their international standing and the peer linkages required to support a career back in New Zealand

www.frenz.org.nz

# The Australia-New Zealand research relationship

RIGHT: New Zealand's National Institute of Water and Atmospheric Research is testing opportunities for future collaborative research voyages. Here a multicorer collects samples of marine organisms.

According to the New Zealand research Funding and Investment Agencies' contract data on international collaborations, Australia is ranked the second most common country that New Zealand researchers collaborate with. Approximately 16 per cent of researchers reported collaborations with their Australian counterparts in 2008-09.

There are a number of Government-led initiatives that frame the New Zealand and Australia research relationship. Some of these are detailed below.

## The biotechnology relationship

The Australia-New Zealand Biotechnology Alliance (ANZBA) co-promotes our biotechnology industries and capability in the international arena. ANZBA members are the State Governments and the New Zealand Government.

The Australia New Zealand biotechnology partnership fund (ANZBPF) supports developing commercial opportunities in the biotechnology/bioeconomy area. The funding is used to build strategic commercial alliances with Australian and New Zealand companies or entities, improving the sustained productivity and global competitiveness of both biotechnology sectors. It has been running since 2003 and at the end of 2008/2009 the fund had awarded 20 grants to the value of NZ$16 million. Some high-profile areas of bilateral cooperation include:

LEFT: Marine research in Antarctica – here a multigrap goes down off a research vessel (above).

## Australian Synchrotron

New Zealand has been an active participant in the Australian Synchrotron project from its inception and New Zealanders have been prominent in both technical advisory and governance roles. New Zealand researchers are using the synchrotron in increasing numbers. In 2009, 45 New Zealand research teams representing a range of institutions conducted experiments on the facility.

## International Square Kilometre Array radio telescope (SKA) project

A cooperation arrangement between New Zealand and Australia to make a joint bid to co-host the SKA was signed in 2009. New Zealand and Australian Government agencies and scientists are working closely on our joint SKA bid.

## Research vessel capabilities and marine observation

New Zealand and Australian officials have met on several occasions to advance collaboration on marine research vessel operations and oceanographic research. A range of options have been discussed from short term exchange of data, to longer term cooperation on use of marine research vessels.

National Institute of Water and Atmospheric Research (NIWA) is currently testing opportunities for future collaborative research voyages with their Australian partners at CSIRO and the Cooperative Research Centre for Antarctic Climate & Ecosystems.

## Light Metals Research

Approval from the Australian Government has been given for CSIRO to include the University of Auckland in its Light Metals National Research Flagship program. This is the first time a New Zealand research organisation has participated as a member of a flagship program.

## Commonwealth, States and Territories Advisory Council on Innovation (CSTACI)

In June 2006 New Zealand formally became a member of the Commonwealth, States and Territories Council on Innovation (CSTACI). In 2009 Senator Carr, with his New Zealand counterparts Brownlee and Mapp, endorsed the terms of reference for CSTACI, with the wider aim of improving the effectiveness, integration and co-ordination of the Australian and New Zealand innovation systems. New Zealand and Australian officials across a range of innovation agencies are increasingly working together to share experiences and coordinate activities. ■

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The University of Canterbury is proud to present its internationally recognised excellence in research to the world. As a trusted and highly successful research partner, UC is home to five major highly-acclaimed research institutions. These include the National Centre for Research on Europe, New Zealand's only research centre devoted to the study of Europe and the European Union (EU) and host to FRENZ which seeks to connect New Zealand and EU research.

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# Building links

NZi3 is the national ICT Innovation Institute based at the University of Canterbury. The Institute is a 'hothouse' of strategic ICT research and aims to be a globally-recognised innovation centre that transforms ideas from the lab, across the innovation gap, into industry.

The University of Canterbury is fostering connections with Europe through its International Centre for Research on Europe and drawing attention for its progressive approach to multidisciplinary research.

The International Centre for Research on Europe is much more than an exchange program for students and academics, with visiting engagements from social and political leaders.

"It's also an opportunity for us to host and engage with visitors from Europe who might be coming to NZ for the purposes of study or enquiry and gives the university a higher profile in issues relating to Europe than it would in the absence of such a centre," says Vice-Chancellor Dr Rod Carr.


Lord Christopher Patten of Barnes visited UC's National Centre for Research on Europe (NCRE) in 2009. The former European Union Commissioner and Hong Kong Governor presented the Europa Lecture, an annual lecture hosted by NCRE and the European Union Centres Network of New Zealand.

University of Canterbury PhD student John Stowers uses a small helicopter as part of his research into unpiloted aerial vehicles. Stowers was the first recipient of an NZi3 scholarship.

In large part, Dr Carr says the value of the Centre is hard to measure as it goes "into the heads and hearts of our students who are at masters or postgraduate level of study." The Vice-Chancellor says that the Centre brings a greater understanding of matters in Europe of interest to New Zealand, such as trade. "There's also strong interest in the emerging Eastern European countries, their economies and their societies, and those involved with the Centre engage not only in business support, but also as a channel for advice to a number of government agencies."

In relation to other New Zealand universities, Dr Carr says that the International Centre for Research on Europe acts as 'gatekeeper and clearing house'.

"We offer assistance to identify opportunities, we advise on proposal development, we support them with contacts and finance guidance. There is a help desk and web resources under the FRENZ structure (Facilitating Research co-operation between Europe and New Zealand www.frenz.org.nz), which acts as a gateway for interaction with European institutions (see page 126).

"The head of the Centre, Professor Martin Holland, is currently the project manager of the FRENZ initiative, plus he is a member of a number of international EU research networks and the focal point for a whole range of New Zealand-EU linkages."

The University of Canterbury also has a dynamic approach to linking research across the different faculties. A university-wide competition asked academic staff to bring forward proposals for funding of two new research institutes, with the prize being a million dollars a year in funding for three years.

One winning proposal led to the establishment of the New Zealand Institute of Language, Brain and Behaviour, which involves collaboration between 30 academic staff from four of the University's five colleges – Engineering, Science, Education and Arts.

Dr Rod Carr, Vice-Chancellor, University of Canterbury.

"It was led by the College of the Arts, leveraging their linguistics insight and capability to proactively engage other interests around campus," Dr Carr says. "Clearly there is a need to capture metadata on behaviours and associate them with a particular brain functions and stimuli," Dr Carr says. "Language and linguistics is an extraordinarily complex learning process of a biochemical nature in the human brain. By bringing together technology from four different fields, the Institute will be able to better understand language learning and language disorders, and how they cross over with learning disabilities and disorders. The way we've brought those together is relatively unique in the world."

The other winning proposal led to the Biomolecular Interaction Centre, which came out of the University's School of Biological Sciences and crosses over with other Colleges, particularly Engineering. A NZ$32m investment in a new biology postgrad laboratory space, will act as the hub in the wheel in the University's network of field stations in the South Island of New Zealand.

"This area is often called 'God's Crucible' because it's got just about everything – alpine ranges, flatlands, freshwater rivers, braided rivers, beech forests and marine environment," Dr Carr says. "This research will then relate to issues such as biosecurity, biotechnology, and biodiversity, all of which is hugely interesting to the international science community and, increasingly, politicians and business decision-makers." ■

# Internationally connected research from the heart of New Zealand.

The University of Waikato is located at the heart of New Zealand's agriculture, research, technology and science heartland and it takes pride in its world-class teaching and research. The University identifies and responds to local, national and international requirements for study options and research to support the wider community and is at the centre of a network of research institutions and industry responsible for a significant proportion of New Zealand's research.

The University of Waikato's Faculty of Science and Engineering is ranked by the New Zealand government as the top science research school and is where you will find some of New Zealand's most respected lecturers and researchers. More than a quarter of the faculty's students are postgraduate, including many international students.

Visit waikato.ac.nz to find out more about the University of Waikato, its international research collaborations and about opportunities for international postgraduate study.

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THE UNIVERSITY OF WAIKATO

*Te Whare Wānanga o Waikato*

# Waikato University makes international connections

International collaboration is at the heart of much of the research that takes place at the University of Waikato's Faculty of Science and Engineering.

The university, which is situated in New Zealand's North Island, prides itself on world-class teaching and research. The New Zealand Government has ranked the Faculty of Science and Engineering the top science research school in New Zealand; more than a quarter of the faculty's students are post-graduate, including many international students.

The University was recently part of the multinational International Polar Year initiative, designed to spark a new era in polar research. The project, led by Waikato University in collaboration with the US National Science Foundation, studied biocomplexity in the Ross Sea.

A team of 15 biologists, hydrologists, chemists and geologists from several universities in New Zealand and overseas were involved in the project, led by Waikato University biologists Professor Craig Cary and Professor Allan Green. The pair brought together a raft of separate, ongoing Antarctic research on lichens and mosses, microbial diversity and small invertebrate fauna.

The University's Vice-Chancellor, Professor Roy Crawford, says Waikato is proud of its international connections. "Waikato University has had a long-standing relationship with the Antarctic, but the funding opportunities thrown up by the International Polar Year provided a chance for staff and PhD students to spend more time on the ice."

Professor Crawford says the University's Faculty of Science and Engineering has sent dozens of staff and masters and PhD students to the ice in the past five years, and more than 50 publications have resulted. That research has spanned everything from the deterioration of the wood in the historic expedition huts, to where the southernmost worm is found, and the uniqueness of Antarctica and its potential for commercial success.

ABOVE: Beautiful spot – Waikato University's campus sits on a stunning 64 hectares.

LEFT: Professor Roy Crawford – Proud of Waikato University's international connections.

BELOW: On the ice – Professor Craig Cary, from Waikato University's Faculty of Science, near Mt Erebus in Antarctica.

Another of the University's international collaborations is with Germany's Bremen University. INTERCOAST, which was launched earlier this year, is a joint postgraduate training program involving international and New Zealand PhD students and researchers.

INTERCOAST stands for integrated coastal zone and shelf-sea research, and the programme sees top scientists from the two universities and New Zealand organisations putting their support behind the project. The German Government's Science Foundation has pitched in with several million dollars.

The two universities already run a joint Masters of Science program, but INTERCOAST is the first project to come out of the New Zealand-Germany Science and Technological Agreement and the first Australasian science collaboration for the University of Bremen. Bremen has one of the world's top oceanographic institutes.

Over nine years, nearly 40 international PhD students and post-doctoral fellows will research New Zealand's Bay of Plenty coastline and aspects of the North Sea. Their first visit to New Zealand in February was an opportunity for international participants to familiarise themselves with the Bay of Plenty region and meet key academics and industry representatives involved in the multi-disciplinary (science, law and social science) program.

www.waikato.ac.nz

# FEAST
## and the case for science diplomacy

**over 1%**

**the rate at which the planet's human population increases each year**

**=**

**about two more mouths to feed every second**

Imagine for a moment that the globe is inhabited by a single individual who roams free across outback plains, through rainforests, across pure white beaches, living off the resources available. Picture the immensity of the world surrounding this one person and ask yourself, what possible impact could this single person have on the planet?

Now turn your attention to today's reality. Almost seven billion people inhabit the planet and this number increases at an average of a little over one per cent per year. That's about two more mouths to feed every second.

Do these seven billion people have an impact on the planet? Yes. An irreversible impact? Probably. Taken together this huge number of people has managed to change the face of the Earth and threaten the very systems that support them. We are now embarked on a trajectory that, if unchecked, will certainly have detrimental impacts on our way of life and to natural ecosystems. Some of these are irreversible, including the extinction of many species.

But returning to that single individual, surely two things are true. A single person could not have caused all of this, nor can a single person solve all the associated problems.

The message here is that the human-induced global problems that confront us cannot be solved by any one individual, group, agency or nation. It will take a large collective effort to change the course that we are on; nothing less will suffice.

Our planet is facing several mammoth challenges: to its atmosphere, to its resources, to its inhabitants. Wicked problems such as climate change, over-population, disease, and food, water and energy security require concerted efforts and worldwide collaboration to find and implement effective, ethical and sustainable solutions. These are no longer solely scientific and technical matters. Solutions must be viable in the larger context of the global economy, global unrest and global inequality. Common understandings and commitment to action are required between individuals, within communities and across international networks.

Science can play a special role in international relations. Its participants share a common language that transcends mother tongue and borders. For centuries scientists have corresponded and collaborated on international scales in order to arrive at a better and common understanding of the natural and human world.

> "the human-induced global problems that confront us cannot be solved by any one individual, group, agency or nation. It will take a large collective effort to change the course that we are on. Nothing less will suffice"

Values integral to science such as transparency, vigorous inquiry and informed debate also support effective international relation practices. Furthermore, given the long-established global trade of scientific information and results, many important international links are already in place at a scientific level. When these scientific links are also supported at a political level, they can provide a 'soft politics' route to other policy

Professor Penny D Sackett,
Chief Scientist for Australia

dialogues. That is, if nations are already working together on global science issues, they may be more likely to be open to collaboration on other global issues such as trade and security.

Many countries have recognised the value of science diplomacy. In March 2010, the United States Congress passed a bill to fund a Global Science Program for Security, Competitiveness and Diplomacy. Earlier, President Obama used his speech in Cairo to announce an expanded team of science envoys in the Middle East, Africa and Southeast Asia.

In April, British Foreign Secretary David Miliband made the case for research as a political bridge. In Australia, there are two science envoy posts, one in Brussels and the other in Washington DC.

In my own role as Chief Scientist, I engage with researchers and agency heads of other nations to improve Australia's scientific relations. For example, my recent trip to the United States included a visit with Professor Daniel Kammen, Clean Energy Envoy of the US State Department, and previous trips have established a connection with Chief Scientists and Scientific Academy Presidents in Britain, China, India, New Zealand and the United States.

Central to these diplomatic efforts is the establishment and continued nurturing of collaboration. Scientific collaboration operates best as a network of individual researchers supported by corporate and government policy and investment. The keys then are forging links at the ground level and providing clear and consistent bi-national and multinational policy and funding frameworks to sustain these links.

> medical research, dryland agriculture, climate science, water management, and tropical and marine eco-systems are just some of the areas in which the world relies disproportionately on Australian expertise

In Australia, we are in a unique position for international collaboration. Our relative geographical isolation and small world fraction has, from the beginning, necessitated self-reliance and native capacity-building on one hand and the need for strong couplings to the bulk of the world's research overseas on the other hand. This means that we bring strong and unique capabilities to the table in addition to our experience in sharing with and learning from others.

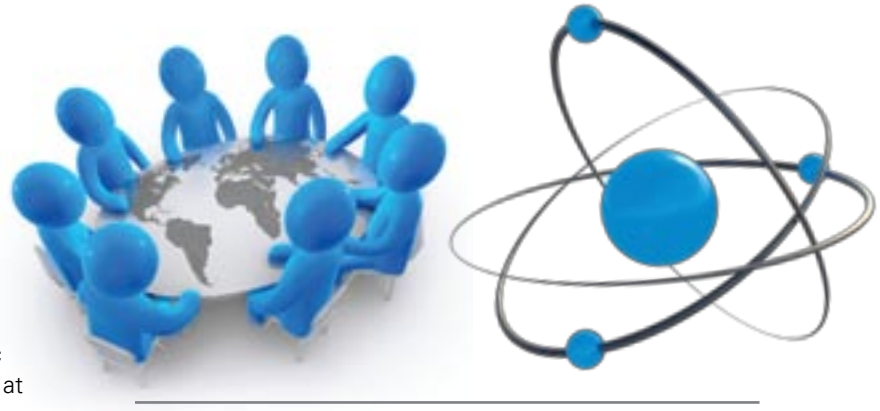
Our vast continent stretches from the tropical north to temperate and semi-desert areas, and includes the Southern Ocean and Antarctic territories, a remarkable diversity of environments that are fundamental to understanding the diversity of ecosystems and interconnectedness of the Earth system. Medical research, dryland agriculture, climate science, water management, and tropical and marine ecosystems are just some of the areas in which the world relies disproportionately on Australian expertise. Increasingly, Australia is seen as an important player in the Asia-Pacific region and a link between the cultures of the Occident and the Orient, a powerful role in world diplomacy.

As one single individual or one single nation, Australians and Australia is neither the sole cause nor the sole solution to global challenges. By nurturing existing scientific collaborations and building new ones, however, we can build bridges of trust and cooperation that will allow a freer flow of knowledge and expertise to the benefit of our nation and our partners, benefit that would not accrue from unilateral action. This, coupled with supportive policies, goodwill, and a desire to use the strengths of our nation for the benefit of humanity, will place us, as Australians, as leaders in international scientific diplomacy, and multiply our greater diplomatic efforts on the global stage. ■

**7 billion**

**the approximate number of people who inhabit the planet**

# THE NEW ROLE
## of science in diplomacy; challenges and opportunities



Since the end of the Cold War – which saw dedicated leverage of science by world powers in the form of hard or military power – national use of science as a diplomatic medium has significantly declined. In recent times, however, there have been indications that the use of science as a means to achieve wider foreign policy objectives has turned around. This embryonic resurgence of science diplomacy as part of a broader diplomatic objective to wield 'soft power' is mostly directed at the global challenges that countries face.

Science provides our understanding of key global issues such as energy access, food security, climate change and infectious diseases, and underpins global responses. It stands to reason, therefore, that scientific expertise should be a fundamental part of diplomatic efforts. As single nations can neither solve them alone nor develop solutions to every problem, scientific cooperation becomes an increasing necessity.

The recent surge in interest in science diplomacy can be seen in a number of countries. For example, in the USA the post of Science and Technology Advisor to the Secretary of State was created in 2000, and in March this year the *Global Science Program for Security, Competitiveness and Diplomacy Bill* was introduced to Congress, which proposes an increase in the application of science and scientific engagement in America's foreign policy. This follows the recent appointment of three US Science Envoys.[1]

In the UK, the Government set up the Science and Information Network (SIN) in 2001, with the aim of linking science more directly to its foreign policy objectives. Earlier, in 1964, the first Chief Scientific Adviser (CSA) was appointed as the personal adviser on science and technology-related activities and policies to the Prime Minister and the Cabinet. Many individual government departments also have their own departmental chief scientist who sit with the CSA on a Chief Scientific Adviser's Committee.

Japan has had a formal policy on science diplomacy since 2007 and has an Ambassador for Science and Technology within its Ministry of Foreign Affairs. China, in its 2006 Plan for the Development of Science and Technology, spelled out how it intends to become an 'innovation oriented society by the year 2020 and a world leader in science and technology by 2050'.[2] France has also recognised the positive contribution that science can make to foreign policy through the provision of science-based advice.

> when primary challenges are also global challenges, science diplomacy is crucial to understanding problems and identifying solutions

While the idea of science diplomacy is not new[3], it is an evolving and growing practice. A meeting jointly hosted by the UK's Royal Society and the American Association for the Advancement of Science (AAAS) in June 2009, explored how science can contribute to foreign policy objectives. The report of that meeting developed three dimensions of this concept[4]:

- scientific advice informing foreign policy objectives (science in diplomacy);
- facilitating international science cooperation (diplomacy for science) ;
- using science cooperation to improve international relations between countries (science for diplomacy).

Potential science diplomacy services that Australia can offer include influence and visibility on international and regional science programs, and geopolitical influence through the provision of science and technology aid to developing countries. These and other aspects are explored further in the Academy's *Internationalisation of Australian Science: A position paper* 2010.[5]

Kurt Lambeck, Professor of Geophysics, Australian National University, President of the Australian Academy of Science, 2006–2010

science is a wide-ranging effort that naturally crosses borders, and global scale projects require the building of bilateral and multilateral relationships and an awareness of emerging opportunities

Science is a wide-ranging effort that naturally crosses borders, and global scale projects require the building of bilateral and multilateral relationships and an awareness of emerging opportunities. Mindful of this, a number of countries have established science specialist networks at embassies and consulates.[6]

Scientific organisations and Learned Academies play an important role in facilitating science diplomacy and coordinating the world's growing number of scientists and the associated growth in data, information and literature. For example, The American Academy of Arts and Sciences has a dedicated Centre for Science Diplomacy with the goal of 'using science and scientific cooperation to promote international understanding and prosperity'.[7]

While Australian governments have a long history of support for international science, over the last 15 years Australia's international science network has been severely diminished. International representation peaked in 1995 when scientific officers were posted in Brussels, Paris, Bonn, Jakarta, Tokyo, Seoul, Kuala Lumpur, London and Washington. In 2007, science counsellors were replaced with education counsellors, leaving only one science counsellor in the Australian Embassy and Mission to the European Communities in Brussels. DIISR also employs two locally engaged staff with science responsibilities in Brussels and one each was subsequently appointed to the embassies in Delhi and Beijing. More recently, a senior officer for science research and innovation was appointed to Washington. It is hoped that the Government's current Parliamentary inquiry[8] into Australia's international research collaboration will find merit in strategic engagement with the international science community and recommend the re-establishment of a Government science network. The appointment of a diplomatic 'Envoy for Science' would be an obvious first step.


When primary challenges are also global challenges, science diplomacy is crucial to understanding problems and identifying solutions. The priority of science in diplomacy is to ensure the effective uptake of quality scientific advice by policy makers. For individual scientists this would translate into collaboration with the best scientists in their field, work in the best research facilities and secure further funding. For foreign policy advocates it can be used to progress wider goals, and promote bilateral and multilateral relations. Taken as a whole, science in diplomacy has the power to inform decisions and serve as a core instrument of diplomacy, helping to build bridges for peace and prosperity worldwide. ■

FOOTNOTES:

1 Cathy Campbell (2010) "Science diplomacy gets a boost with new bipartisan bill" at: http://blog.psaonline.org/2010/03/18/science-diplomacy-gets-a-boost-with-new-bipartisan-bill-2/

2 The Central People's Government of The People's Republic of China, *China issues S&T development guidelines* at: http://www.gov.cn/english/2006-02/09/content_183426.htm

3 For example, a 1979 agreement between the US and China paved the way for bilateral scientific cooperation, and US and Soviet NGOs contributed to the Cold War thaw through scientific exchanges, with little government support.

4 The Royal Society (2010) "New Frontiers in Science Diplomacy: navigating the changing balance of power" at: http://royalsociety.org/New-frontiers-in-science-diplomacy/

5 Found at: http://www.science.org.au/reports/documents/InternationalisationAustralianScience.pdf

6 For example, SIN has expanded since its establishment in 2001 to include 90 staff in UK embassies, high commissions and consulates in 40 cities around 25 countries.

7 AAAS at: http://diplomacy.aaas.org/

8 The Report of the House Standing Committee on Industry, Science and Innovation's Inquiry into Australia's international research can be found at: www.aph.gov.au/house/committee/isi/intresearch/report.htm

# GLOBAL science and policy priorities

In this post-GFC world, it is striking that no-one seems to use the word "globalisation" much anymore. Perhaps this is implicit acknowledgement that we are already globalised, that we already have a system in which financial troubles can spread almost instantaneously, affecting many countries at once.

But in science, the globalisation is still happening – there are slower and quieter adjustments taking place which will have long term implications for Australia. The traditional Northern Hemisphere science superpowers – the USA, Europe, Japan – still produce most of the world's new knowledge and researchers, and exert a powerful pull of attraction as a result. But, as Sylvia Schwaag-Serger from Vinnova and the University of Lund in Sweden has recently pointed out, the centre of gravity of global science is spreading out, moving east and south.

At the same time, science is contributing to the responses to the major challenges and opportunities of our time – issues such as climate change, energy and food security, which are by their very nature global. Mark Matthews at the ANU's new Centre for Policy Innovation writes that while collective responses to these issues do not rely exclusively on research, our commitment to "evidence-based policy" means that it is rarely the case that these responses do not require research. This research will less and less be produced by one nation alone.

In this context, the idea of "science diplomacy" has recently regained currency, as a useful concept in navigating the role of science in addressing global policy priorities. But what is science diplomacy exactly? And how can we develop an Australian approach to it so that we are not at a strategic disadvantage?

The foreign policy community has, over the last few decades, demonstrated a fairly hard-boiled view of science diplomacy, focusing on the ways in which science could be useful for the prosecution of distinct foreign policy objectives. Scientists could assist with the verification of technical details relevant to the control of nuclear and chemical weapons. The international engagement that scientists were undertaking could also be used to maintain links with governments with whom other relations were strained.

Earlier this year, the UK Royal Society, in partnership with the American Association for the Advancement of Science (AAAS), released a landmark report entitled *New Frontiers in Science Diplomacy: Navigating the changing balance of power*, which provides a broader and more sophisticated view of science diplomacy.

The report notes that the idea of science diplomacy is still developing but describes three different aspects that can be usefully classified:

- science in diplomacy, or the role of science in informing foreign policy objectives;
- diplomacy for science, or the role of governments in facilitating international science cooperation; and
- science for diplomacy, or the ways in which science can contribute to improved international relations.

This description of science diplomacy helps us to move beyond a cold-war view of science, and to understand how it contributes to wider foreign policy objectives and policy challenges.

The report also describes the ways in

> "international engagement that scientists were already undertaking could be used to maintain links with governments with which other relations were strained"


which other governments are taking science diplomacy seriously, and actively promoting and facilitating international science as a way to achieve their policy aims. The Japanese government, for example, has an explicit policy on science diplomacy, which aims among other things to attract inward investment and increase Japan's standing internationally. Countries such as China and India place clear importance on science in their foreign policy, and use diplomacy as a means of accessing knowledge produced elsewhere.

Using the report as a starting point, we now have an important opportunity to flesh out our understanding of science diplomacy even further, and to think in more detail about the nexus of science and Australia's national and international interests.

Last year for example, the Lowy Institute released a report entitled *Australia's Diplomatic Deficit: Reinvesting in our instruments of international policy*, which pointed out that 18 of 19 Federal Government departments have created their own international policy branches in recognition of the international dimension of almost all major policy issues – CSIRO regularly receives requests from most of these seeking scientific input. This also of course raises a question of coordination, for scientists and policy-makers alike.

Science is inherently global in that new knowledge is produced and improved through international processes, collaboration and networks of peers. And these processes and networks are continuing to globalise. But national governments fund and set policies for science, and in the wake of the Global Financial Crisis, science has more than ever before been tied to national productivity and competitiveness objectives through national innovation policies.

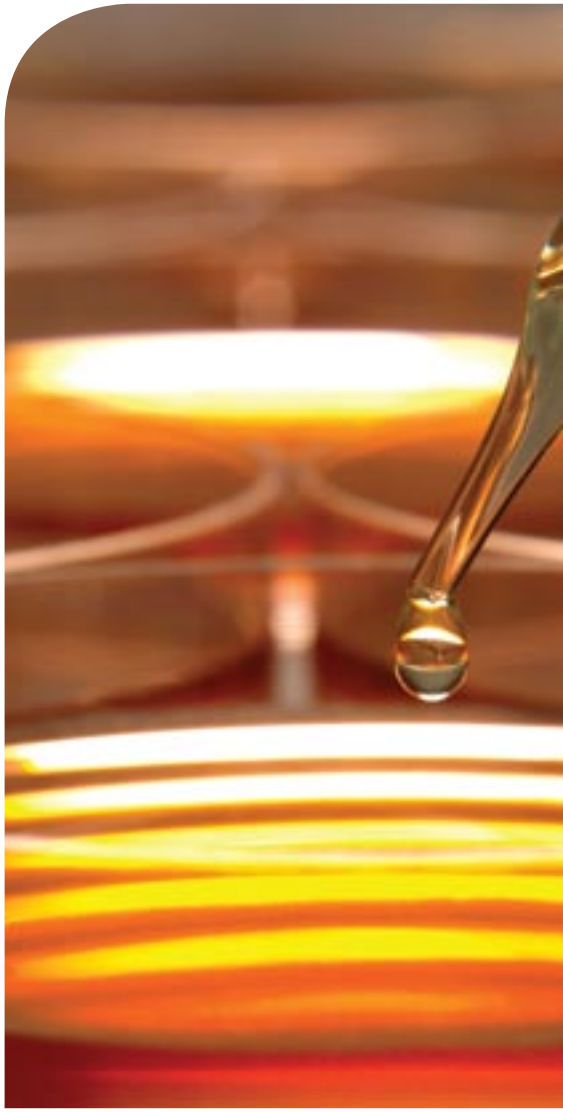
Given our place in the world, Australia will necessarily have a different approach to science diplomacy than major Northern Hemisphere powers. We have an opportunity to lead the further development of this thinking in the context of innovation policy. In addition to national and international policy challenges such as climate change, we could also improve our understanding of how science contributes to the national and international objectives of innovation, trade and aid policy. CSIRO for example has strengthened its links with both AusAID and AusTrade in the last couple of years.

In a multipolar world, science will be helped by being able to better articulate its role in addressing overlapping national and international objectives, and foreign policy will find value in a broader range of science and its global networks. Improving science diplomacy is clearly in Australia's interests.

*Paul Harris is General Manager of Government and International Engagement at the CSIRO, and a Visiting Fellow at the ANU Centre for Policy Innovation. Email* p.harris@csiro.au.

This article first appeared in The Australian newspaper

# A CASE FOR Global Research Compacts



The Federal Budget's transition to fully funded research has been strongly welcomed by the sector. It addresses a plethora of problems within Australia's universities – broadly associated with the 'politics of cross-subsidies'– which were caused by the chronic failure to cover the indirect costs of research. As these impediments diminish, it will be easier for our universities to develop and pursue distinctive missions. This will be further helped by a move to develop far better data on what it actually costs to do the different things that universities do. As a result it will be much easier for universities to plan and deliver rational resource allocations.

> researchers should be given 'room to manoeuvre' in quickly setting up cooperative links by using their core research funding – and to be far more relaxed about how much of their budget they spend on international cooperation

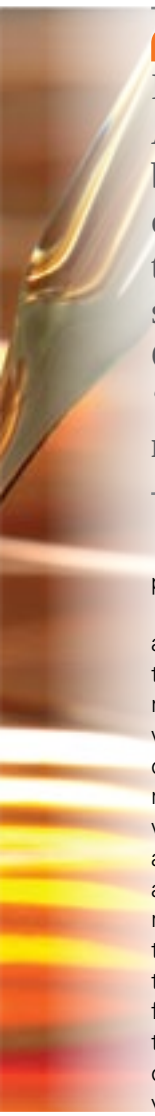
However, this has implications for another feature of the contemporary university research landscape: the transition to viewing international engagement as part of the core business of doing excellent research. No longer just an 'optional extra' to domestically-oriented research, it is now seen as a prerequisite to delivering useful social, environmental and economic outcomes from our research.

Effective international work is a 'productivity multiplier' – it allows for economies of scale and scope to be exploited together with reduced duplication of efforts. This is particularly important when major global challenges exist for which urgent coordinated national responses are important.

As it is becoming easier for core research funding to support international cooperation, dedicated funding to support international research cooperation is being reduced. Researchers should therefore be given the 'room to manoeuvre' in quickly setting up cooperative links by using their core research funding – and to be far more relaxed about how much of their budget they spend on international cooperation. This is preferable to the additional red tape associated with 'add-on' funding for international engagement, which is often not fit for purpose because the lead times are too long and the synchronization with overseas funding rounds and procedures is poor.

International cooperation becomes 'endogenous' rather than 'exogenous'. However, with the move to fully funded research this raises an interesting issue:

Cutting-edge research that is fully funded must provide adequate support for international engagement.



> I see no reason why Australia could not also be seeking to play a catalytic role designing the architecture for a system of Global Research Compacts. This would 'future proof ' the current reforms

How can this be achieved in practice?

The distinctive missions associated with Compacts, which the Government has proposed as a mechanism to provide universities with a more flexible and outcomes-oriented funding policy approach, may be helpful here – and not just within Australia. Globally, there is a growing challenge in developing and governing major multilateral research collaborations and perhaps there is a role for Global Compacts that intersect with more nationally focused Compacts. A Global Compact targeting a particular research objective would provide a mechanism via which an international network of universities and government agencies could support the (pooled) additional costs of mission-oriented research based upon international cooperation. In most cases, as current experience tells us, this sort of arrangement just needs to facilitate exploiting latent synergies between existing – already funded – research. While a small amount of additional funding may be required, this effectively leverages existing funding in various countries and multilateral programs.

Global Compacts could be formed via inter-governmental agreements and would benefit from the existence of standard legal templates defining how the financial and intellectual property arrangements would be executed. For instance, one species of Global Compact could be specifically designed to interface with the European Union's Framework Programme for Research and Technology Development – reducing the risks and transaction costs of participating non-EU nations.

On a national level each university would be free to define its own distinctive mission – to include strategic participation in specified Global Compacts. Funding for the full costs of research would then be able to factor this participation in Global Compacts into the equation via the university specific Compact.

In the current transition to fully funding the cost of research, with international cooperation as part and parcel of the model, I see no reason why Australia could not also be seeking to play a catalytic role designing the architecture for a system of Global Research Compacts. This would 'future proof ' the current reforms.

I propose a two-pronged approach of:

1. leaving a window open for a system of domestic Compacts for universities that will be able to interface with a system of Global Research Compacts; whilst at the same time
2. pursuing multilateral discussions over what an effective system of Global Research Compacts could look like.

As a start, an option to participate in the EU Framework Programme built into the new system of Compacts in Australia could provide a core of discretionary funding to each university (based upon track record). This funding would allow for 'agile' and strategic allocations by that university to provide for its researchers to participate in future Framework Programme projects.

The Forum for European-Australian Science and Technology cooperation (FEAST) is actively investigating these issues. We have advocated the establishment of an International Bureau, based upon a model developed in Germany, for improving how we handle the wide range of Australia's international cooperative activities – including intergovernmental aspects. For instance, we have undertaken a major 'stocktake' evaluation of the benefits, costs and the risks associated with Australia's current pattern of research cooperation with Europe. This will contribute to discussions of the value for money that Global Research Compacts might represent. For more information on the 'stocktake' evaluation see the article on page 146.

www.feast.org

*Dr Mark Matthews, FEAST*

This article first appeared in Australian R&D Review

# THE ECONOMIC COST in reducing international research collaboration

The Academy of Technological Science and Engineering (ATSE) has warned the Government of the dangers of reduced international research collaboration and called for a significant funding boost.

International research collaboration played a key role in ensuring that Australia maximised the benefits from its investment in research and innovation, ATSE told an inquiry into Australia's international research collaboration by the House of Representatives Standing Committee on Industry, Science and Innovation.

ATSE's submission noted the Academy's unique contribution to international research collaboration in opening new, and enhancing existing, pathways for science and technology cooperation with priority countries. Its networks with research institutions and other academies had led to tangible benefits for Australian research and business.

It noted that research quality – as measured by citation impact – was three times higher for Australian researchers who collaborated internationally compared with those who did not.

ATSE acknowledged the increased investment the present Government had made in science, technology and innovation, but noted that commitment of a new program of international research collaboration funding was one area still to be addressed.

ATSE recommended that the Government significantly increase funding for collaboration under the bilateral agreements to give these agreements critical mass – proposing overall funding for the International Science Linkages (ISL) Program should be increased to A$30m a year.

The ATSE submission noted ISL funding, which includes support for bilateral activities and ISL Special Academies Program (ISL-SAP),

had been A$94.5m over nine years. Funding for this Program expires in the near future.

In a supplementary submission, ATSE said lack of long-term funding commitments by the Australian Government in the ISL-SAP program could jeopardise productive collaborative Science and Technology (S&T) relationships that had been successfully established to date.

It said the importance of international collaboration in building quality research and innovation in Australia – and its positive contribution to Australia's economic wellbeing – was hard to overstate.

The ongoing support of international research collaboration was particularly needed in Australia as the nation worked to address its poor performance to date in research to 'big-business' links.

Through strategic research linkages to those countries with successful innovation investments and linkages to global big business, Australia could benefit from significant industry investment in research innovations, it said.

The participation of Australian researchers in major multi-country European 'Framework Programme' projects sponsored by the European Commission was an important example of international research collaboration, ATSE said.

This Programme supported large-scale consortia comprising leading researchers from across Europe. All participants in Framework Programme projects shared the results. Competition for funding from this source was very strong, so when an Australian research team was a member of a successful application consortium, they would collaborate with the best European researchers in their field.

On a still larger scale, research collaboration also gave Australian researchers access to megascience projects. These research projects involved expenditure even greater than that of the European Framework Programme and were too expensive for any one country to undertake.

Through international research collaboration, Australian researchers could participate in these projects and Australia could benefit from the knowledge and expertise generated. When Australia was a partner in some large-scale research projects there were valuable opportunities for Australian firms to win contracts to supply components of the research equipment – the notable example being large telescopes.

ATSE noted several key drivers of international research collaboration:

- Government – by ensuring that Australian researchers, research teams and businesses could access world leading partners and equipment – particularly through support for international research collaboration;
- Institutions – by recognising that international research collaboration contributed to the recognition of the quality of Australia's science and technology capability and to the high international recognition for research excellence which Australia enjoys; and
- Researchers – by understanding that (given the size of Australia's research community) international collaboration provided a very important means, for some researchers, of working with their peers, which is of critical importance for the development of leading-edge research capacity.

ATSE recommended strong support of a Science Counsellor network at Australian embassies and high commissions.

Australian science counsellors located at overseas posts played a vital role in international research collaboration in earlier years, ATSE said. It also emphasised that Australia needed science counsellors in our key embassies and high commissions who understood the different elements of our national science and innovation system and could facilitate connections with counterparts in other countries.

These were essential if Australia was to obtain optimum benefits from investment in international collaboration.

Their role should include:

- meeting the needs of Australian research funders and performers as well as those involved in science policy formulation;
- facilitating Australia's engagement with science and research in the countries to which they are accredited;
- ensuring that Australia was appropriately represented in science-related activities in these countries;
- providing assistance to visiting Ministers, science and technology-related delegations, and other high level visitors;
- assisting links between Australian research performing and funding agencies and their foreign counterparts;
- representing Australia in various science-related activities including local science counsellor networks;
- assisting Australian researchers to obtain funding and other support from foreign sources; and
- supporting major Australian science projects such as the Square Kilometre Array and initiatives such as the Global Carbon Capture and Storage Institute.

> the ATSE noted that research quality – as measured by citation impact – was three times higher for Australian researchers who collaborated internationally compared with those who did not

*Both submissions (63 and 63-1) are at* http://www.aph.gov.au/house/committee/isi/intresearch/subs.htm

# ENHANCING RECIPROCITY in international cooperation in research: issues and metrics

Policies for research are developed and implemented within a complex nexus of national and international imperatives and interests. Research is inherently global in that new knowledge is produced and improved through international processes, collaboration and networks of peers.

There is a growing recognition of the need to improve the efficiency and the effectiveness of those areas of research that address collective international interests. This is especially important with major global challenges such as climate change, energy and food security – areas in which there tend to be collective security concerns, broadly understood. In such cases the advantages of more effective international cooperation tend to outweigh the disadvantages because of both the collective benefits and the enormous collective costs of failure.

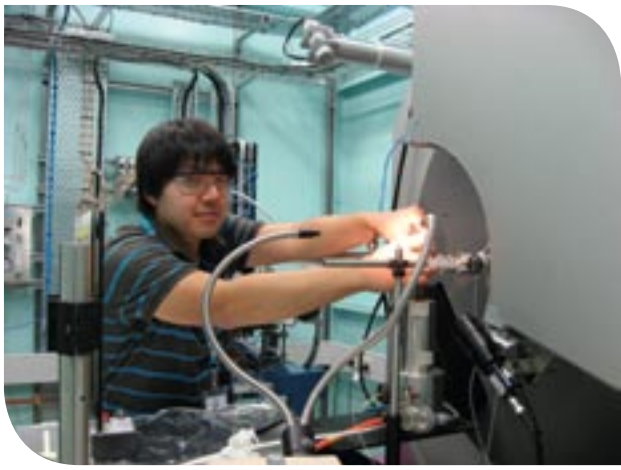
In order to address these challenges, barriers to researcher mobility need to be lowered. Open and/or reciprocal relationships via which researchers in one country can access research mechanisms in another country need to be built up. Impediments to stronger bilateral and multilateral research cooperation need to be identified and removed. Moves in this direction should reduce unhelpful duplication of efforts in research and allow the economies of scale and scope associated with coordinated global research to be better exploited.

As research policy has been more and more entwined with innovation objectives, an over-emphasis on innovation through mechanisms such as commercialisation has tended to divert attention away from the collective public interest outcomes that arise from research. As both research itself and these collective action issues continue to globalise, enhanced international cooperation will be essential to ensure that national governments are connected and prepared.

It will also be necessary to develop policy architectures that seek to achieve an effective balance between national competition and international cooperation in the innovation domain itself. There are many areas in which the technology development aspect of innovation benefits significantly from international cooperation (for example sharing the cost of expensive large-scale demonstrator projects, pooling competitively 'redundant' segments of corporate patent portfolios to achieve collective competitive advantage etc). This means that although there is a general structural limitation to international cooperation in the innovation domain due to the national competition dimension, there is still significant scope for international cooperation provided that the 'value proposition' is clearly and pragmatically defined.

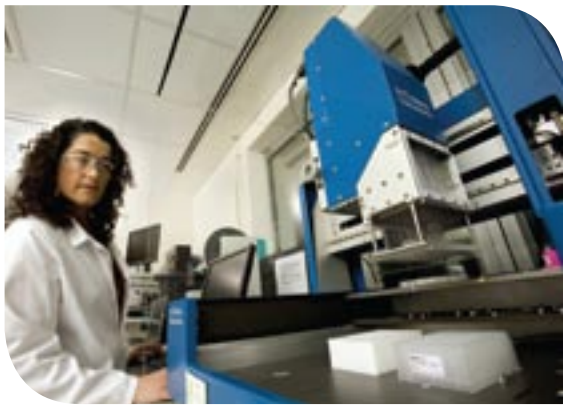
## Reciprocity and science diplomacy

In the new internationalised research regime that is emerging, reciprocity and openness in research funding are likely to become key concerns in diplomacy – just as they have traditionally been in trade. Barriers put up to limit international engagement in research (whether deliberate or unintentional) will start to attract the same sort of negative attention as have long existed in trade negotiations and disputes. In the emerging era, major research funders (e.g. the European Research Council and the US National Institutes of Health) are open to receiving proposals from citizens of other nations residing in other nations. The stipulation is



ABOVE: Dr Yansen Lauw aligning an ionic liquid sample on the powder diffraction beamline at the Australian Synchrotron. *Photo by: CSIRO Process Science and Engineering.*

BELOW: Dr Janet Newman, facility manager of the Bio21 Collaborative Crystallisation Centre, with the the Phoenix nanolitre dispensing robot setting up a 96 well crystallization experiment. *Photo by: David McClenaghan.*



Artist's impression of the Australian Synchrotron by day, from the entry on Blackburn Road. . The Australian Synchroton and the Australian Square Kilometre Array Pathfinder (ASKAP) are just two examples of shared global facilities that are operating for national and international imperatives and interests.

usually that the research grant can only be taken up via a host institution in the donor nation or national block (in the European Union's case). Furthermore, these major research funders are also developing reciprocal access relationships that do not require researcher relocation (e.g. the reciprocal funding access arrangement between the US National Institutes of Health and the health domain of the European Union's 7th Framework Programme). Of course, such (major) benefits will not be open to nations that choose to exclude themselves from the emerging international research system. A failure to articulate and develop a capability to act as a fully 'inter-operable' partner in collective global multilateral research activities and bilateral arrangements will limit the efficiency and effectiveness of the 'national' research effort in smaller economies.

## International research cooperation and national policy formulation

The inter-connections between research policy and other policy domains highlight the importance of developing effective mechanisms within government for partnering with the research community (nationally and internationally).

If policies are to be 'evidence-based', then it is increasingly likely that this evidence will either be derived from, or strongly influenced by, findings from research (and rarely research results exclusively from a particular nation). Consequently, nations that pursue highly nation-centric approaches face a 'double whammy'. They risk becoming isolated from the mainstream because they cannot demonstrate 'good global citizenship' in collective responses to global challenges. Secondly, they will have sub-optimal access to the results and insights arising from the collective international research effort. In most cases this sub-optimal access will be manifested in only becoming aware of significant research findings when work is published (and accessible to all). Given the key role of governments in handling the uncertainties and risks that markets cannot cope with very effectively, the early warning of significant findings gained from the pre-publication phase and facilitated by engagement in major international projects is a key benefit in most policy domains.

## The European Union and reciprocity mechanisms for international cooperation

The EU has recognized the importance of more effective bilateral and multilateral coordination in science and technology cooperation with the implementation of the ACCESS4EU projects. These are a set of inter-connected projects which aims to raise awareness amongst Europe-based researchers of the funding opportunities that support collaboration with colleagues in a range of non-European nations. Currently the European Union has funded projects in Australia, Brazil, Canada, China, India, Mexico, New Zealand, Russia, South Africa, South Korea and the United States. These projects target both research and innovation support programs.

The projects are collecting and disseminating data on:

- Access opportunities for European researchers in each country;
- The distinctive research and innovation strengths and capacities in third countries;
- Current levels of European participation in third country programs;
- Current third country policies on international collaboration as it may affect European participation; and
- Any obstacles to the participation of European researchers in third country programs.

The Australian project is led by the International Bureau of the German Federal Ministry of Education and Research and also involves FEAST, the Commonwealth Scientific and Industrial Research Organisation (CSIRO) and the British Council. FEAST is also carrying out some exploratory work on the potential for developing measures of openness and reciprocity in access to national research funding systems.

## Metrics – the measurement ethos

If nations are to make clear where they stand in regard to openness and reciprocity in research funding then a new type of comparative dataset is required. It would be useful to develop a version of international rankings that details both relative openness in research funding (the proportion of national R&D accessible by overseas researchers) and the comparative absolute levels of national funding that are open in this sense. This type of dataset would allow for:

- different degrees of national openness at a particular point in time to be assessed and communicated;
- time trends in openness to be monitored and their implications assessed. ➤

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Dense Aperture Array. © Copyright SKA: enquiries@skatelescope.org

Such an overview would, in turn, draw the attention of policy-makers worldwide to the importance of policy stances that emphasise openness and reciprocity, in so doing helping to implement the policy directions highlighted above.

The Australian Government has, for example, committed to the further opening of national research and innovation programs to international participation. In its Powering Ideas policy statement, released in 2009, and in government announcements made before and since, the guidelines for programs such as Australian Research Council grants and fellowships, the CSIRO's Flagship Collaboration Fund and the R&D tax credit, have all been deliberately altered to boost international collaboration and investment. Further work is now clearly required to situate these policy changes within the context of efforts of other governments, and to demonstrate the effectiveness and take-up of these changes.

## Formulating a basic system of metrics

There are two components of a basic system for measuring openness and reciprocity in national research and innovation funding regimes:

- Defining what openness means in practice and establishing how to measure the 'open' proportion of each nation's research and innovation budget; and
- Deploying this openness metric to measure the absolute level of open funding in each nation and the relative proportion of that nation's research and innovation funding that is open.

The first component is the trickier one. We need a metric that covers both the formal rules and guidelines and the practical implementation of these rules and guidelines. To use a pertinent example, a nation may have a funding scheme in theory fully open to overseas researchers. However, that nation may also impose such strict and onerous visa requirements that in practice make it almost impossible to actually take up the award.

One fairly simple approach would be to adopt a three-stage calculation using the three aspects of:

- capacity, the amount of funding available;
- commitment, the extent to which a funding mechanism allows for international access; and
- clarity, the extent to which guidelines are easily grasped by an international researcher in a timely manner. *See box for details.*

This would be a first step to comparing, and indeed ranking, the openness of nations' funding regimes.

The next phase would be to implement this approach experimentally and to assess the accuracy and usefulness of the results obtained in the context of the ACCESS4EU program as a whole.

It would be useful to explore these measurement issues further by:

- defining a hypothetical 'gold standard' fully open research funding program for use as a comparator;
- developing suitable indices for assessing real funding programs against the hypothetical benchmark;
- developing a simple website user feedback mechanism to populate the test indices, and;
- testing this metrics system, and website user feedback mechanism, for three selected nations (including Australia).

We would hope that the results from this exploratory work would encourage greater openness and reciprocity in international cooperation in research in both the policy and the practical realms.

*Dr Mark Matthews, FEAST*
*Paul Harris, General Manager, Government and International Engagement, CSIRO*

**Capacity** [converted to €];
**Commitment:** [measured on the scale $C_1$ $0 < x < 1.0$], and;
**Clarity:** [measured on the scale $C_2$ $0 < x < 1.0$].

Capacity (€ AVAILABLE), commitment ($C_1$) and clarity ($C_2$) can then be related in the following simple equation:

$$€\ \text{OPEN} = €\ \text{AVAILABLE} \times C_1 \times C_2$$

The use of this equation would allow us to calculate the value of funding that is open both in *theory* and in *practice*.


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# STOCKTAKE of Australian engagement with FP7

Dr Rado Faletič
Mr Jean-François Desvignes-Hicks, FEAST

FEAST has conducted a comprehensive survey of Australians involved with the European Union's Seventh Framework *Programme for Research and Technological Development* (FP7) covering the background, expectations, risks, rewards and outcomes of their engagement. We looked at both successful and unsuccessful proposals. These interviews enable FEAST to present robust evidence of successful strategies and tactics, and practical advice on how to engage with FP7.

## Methodology

Utilising the data from the beginning of FP7 (December 2006) until May 4, 2008, FEAST extracted details for all eligible collaborative projects from the following categories:

- Cooperation (all thematic areas);[1]
- Capacities (SiS: Science in Society);
- People (IAPP: Marie Curie Industry-Academia Partnerships and Pathways and ITN: Marie Curie Initial Training Networks).

All other projects were excluded, notably the remainder of the Marie Curie and Capacities categories, and all European Research Council (ERC) proposals. The resulting list of projects numbered 112.

> nearly 90 per cent had entered into their current FP7 project via an existing relationship with an European-based colleague… Many of the pre-existing relationships were initially established via a lab visit or an overseas sabbatical

## Project background

All but one of the participants had substantial academic[2] experience (20 years on average), though with very little industry or government experience.

Over two thirds of the participants had previously spent substantial time in Europe, either for research training or as a researcher. Almost all had prior links with Europe, with just under 60 per cent previously working on formal collaborative projects.

Almost half had former experience with Framework Programmes, with approximately one third of these having been involved with more than one other FP project. Most, nearly 90 per cent, had entered into their current FP7 project via an existing relationship with an European-based colleague. The remainder had received an unsolicited approach as they were seen as being internationally recognised experts in a field of key importance to the project. Many of the pre-existing relationships were initially established via a lab visit or an overseas sabbatical either to or from Europe.

On average, participants spent 0.9 equivalent in person months working on the proposals.[3] The timeframe between the initial approach to the Australian partner and the proposal submission averaged around half a year.

## Expectations of involvement

The primary reasons for joining an FP7 consortium were linked to the scientific performance of the individual investigators and their research groups.

FEAST collected data on a range of expected benefits that can be loosely gathered into three categories:

1. Synergies – to exploit economies of scale and complementary expertise;
2. Access – to obtain privileged access to

knowledge, facilities, people, results and methodologies;

3. Relationships – to establish or further professional relationships and networks.

All three categories were generally considered central to engaging with FP7 (between 80-90 per cent of participants), while less than one quarter of participants indicated that institutional/strategic considerations contributed to their decision to participate.

## Risks

It is no surprise that the greatest perceived risk, prior to submitting an application, was the necessity of obtaining additional external funding (keeping in mind that Australian participants are not eligible to receive funding from the European Commission, except under specific circumstances)[4]. Just over half of participants highlighted this issue. Interestingly, many of the participants did not have a strategy for ensuring adequate funds. This also led most of these participants to highlight the potential risk of not fulfilling their project commitments.

Problems arose in some instances due to a lack of bid-synchronisation between FP7 and Australian funding programs. The difficulty of finding dedicated funding to support travel, or for seed funding for proposal preparations and project commencement, was raised. Many participants also commented on the lack of any matching funding schemes available in Australia (with the exception of the National Health and Medical Research Council [NHMRC] *Australian-European Union Health Research Grants*).

The administrative burden was another significant perceived risk (noted by 45 per cent). Among the remainder of the participants, however, there was an understanding that the bulk of the administrative burden would be borne by the European project coordinator.

> almost 70 per cent of the participants had been given incorrect or misleading advice regarding FP7

The experiences of successful projects demonstrated that many participants underestimated the length and complexity of contract negotiations. A number of participants had ongoing reporting requirements that they described as "onerous" in light of their involvement and the level of (or lack of) funds they were receiving from Europe.

Some participants commented on the necessity to clarify intellectual property (IP) access upfront, with several feeling pressured to share their intellectual property with the rest of the consortium.

Unfortunately, few of the participants sought expert external advice on their participation. Ninety-five per cent of participants relied heavily on their European project coordinator for advice, and over three quarters did not seek any further external guidance.

As a result, there is strong correlation between those who did not seek external advice (from FEAST, National Contact Points or their research office) and those who were provided with incorrect or misleading information regarding the nature of their participation (including eligibility to receive European funds). FEAST determined that almost 70 per cent of the participants had been given incorrect or misleading advice regarding FP7. ➤

**45%**

**of participants described the administrative burden of FP7 applications as another significant perceived risk**

**Several participants were able to identify strategies that dramatically lowered the risks. These were:**

- **The ability to participate irrespective of receiving additional funding. This has the further benefit that if no funding is delivered to the Australian partner from the consortium, then the Australian partner is able to include, as a part of the EC contract, a clause excluding them from any financial reporting.**
- **The necessity to be involved with a coordinator that has a good track record of involvement with the Framework Programmes (this may be an experienced external consulting agency).**

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* *The Times.* HES. Oct 2009. CRICOS #00120C

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## Costs

On average, each of the Australian partners in the successful project proposals (as well as in two of the unsuccessful proposals, which have continued as non-FP7 projects) committed A$288,000 of their own resources (in-kind contributions and/or existing funds), and had access to A$302,000 in additional domestic funding. Approximately half of the successful projects had not received any additional funds at the time of the interview.

## Outcomes

The most important team outcomes for both successful and unsuccessful proposals are the furtherance of inter-personal networks, increased awareness of the team's capabilities and informal technical know-how.

While it was too early for most of the successful projects to have produced any concrete outputs, researchers identified four primary expected outputs:

1. Peer reviewed journal articles
2. Refereed conference papers
3. Events, including workshops, conference and exhibitions
4. Staff and postgraduate exchanges.

## Experiences

Overall, the participants agreed that cooperation with Europe was generally a positive experience. The costs and risks involved were acceptable given the potential benefits. However, experiences with Australia's other major international collaborators (notably the USA, China and Japan) were generally viewed as being more rewarding than those with Europe.

The major drawbacks of the European programs were the perceived bureaucratic burdens, and perceptions of political involvement in the creation and selection of successful projects. A number of participants felt that FP7 had many "unwritten" requirements, and that there was inconsistent implementation of the rules by EC officials.

In contrast, many participants identified the USA as having transparent programs that were more focused on outcomes rather than processes and that were more willing to fund international groups and to a higher degree.

**A$288,000**

**the average amount of their own resources (in-kind contributions and/or existing funds) committed by the Australian partners in successful project proposals**

## Best practice summary

Combining the results of this survey with FEAST's experience in the area, the following best-practice methods can be recommended to all current and future Australian participants in FP7:

- Seek expert advice outside of the consortium from FEAST staff, your research office or other support networks. Involve local research managers from the very beginning of the proposal.
- Select projects and consortia carefully, look at the Framework Programme track record of the coordinator.
- Know your position of strength, and the value you bring to the consortium.
- Be clear on what you will get out of your participation, and what the costs of participation will be.
- Create a fallback position where you can maintain a level of participation without the need for additional external funds. If you do not receive funds from the project, be sure to add a clause to the contract that excludes you from reporting obligations. If your participation does require additional funds, prepare for a potential time lag between the beginning of the FP7 project and the receipt of appropriate funds from Australian sources.
- You should not need to be involved in any financial reporting (unless you are a work package leader and/or you received funding from the EC for this project).
- After the proposal has been evaluated, retrieve the evaluation reports from the project coordinator.
- Clarify your IP sharing arrangements. These need not be with the entire consortium, you are free to make agreements with individual partners.

http://www.feast.org/index/document/3 includes a summary of evaluated projects and charts of the survey results.

FOOTNOTES:

1 Note that while no thematic areas were excluded, there were no recorded projects in the Space or Security themes. For a full list of the thematic areas of FP7 see http://cordis.europa.eu/fp7/cooperation.

2 Researchers working at CSIRO were considered "academics", as the nature of their research was more akin to academic research than government or industry work.

3 If we consider the typical earnings of a professorial researcher in Australia (some A$135,00), this would equate to approximately A$10,000 in direct salary costs.

4 For detail on Australia's eligibility to receive EC financial support, see ftp://ftp.cordis.europa.eu/pub/fp7/docs/guideline-third-country-participants_en.pdf.

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# ENHANCING INTEROPERABILITY in the emerging global research order

The concept of *interoperability* in science and technology provides a practical approach to achieving enhanced international cooperation. Interoperability in an international S&T context refers to the development of the capacity to configure cooperative research activity quickly and cost-effectively in such a way that it exploits complementary capabilities. The vision is to be able to move quickly to work together, be flexible in how this work evolves (changing direction, adding new partners easily) and disengage quickly and easily when objectives have been met or the need for cooperation otherwise dissipated. This more agile approach complements more rigid project-based approaches (characteristically slow to start and hard to re-direct in the light of experience and unanticipated developments). Interoperability based approaches exploit synergies between existing and complementary research in different nations.

While the notion of enhancing interoperability in scientific and technological cooperation makes sense in itself, there are a range of complicating considerations and impediments to be faced. Most importantly, we are moving towards a multi-polar world order. Western cultural and ethical norms and West-centric approaches to civil society, international institutions, legal and financial regulation will no longer be *the* dominant organising regime and consequent focus for less developed nations' catch-up activities. We are likely to see the emergence of a far more complex system of more (and less) powerful nations with distinctive political-economic configurations. Communist-capitalist hybrid forms will co-exist with capitalist-democratic forms. The global triumph of market democracies over other forms of political and economic organisation is no longer a tenable hypothesis. In short, we are moving from a single 'ladder of ➤

> "we are moving from a single 'ladder of development' ideology to a more complex matrix-like structure of more varied political-economic configurations and more politically sensitive alliances"

## SYMPOSIUM OBJECTIVES

The objectives of the Symposium are to:

1. Refine and develop the notion of *interoperability* as a new strategic objective in facilitating international cooperation in science and technology.
2. Consider the implications of the geopolitical dimension to international cooperation in science and technology for delivering enhanced *interoperability*.
3. Develop and propose improved policy stances able to balance the inherently international role of public science against the national competition-driven emphasis on innovation.
4. Explore new forms of agile contractual templates able to facilitate *interoperability*.
5. In the light of the above, agree a joint stakeholder statement and cooperative action plan for refining and demonstrating the interoperability-based approach in a politically sensitive geopolitical context.

**Organisation**

The Symposium is being organized by FEAST in partnership with the University of Queensland.

Unlike many events of this type this will *not* be a forum for researchers per se (who tend to have specific vested interests). Rather, it will be a forum at which those people who must decide on the architectures of funding programs and international agreements can get together to share experiences and new ideas for mutual benefit.

As such, this will be an invitation only event spanning two days with numbers capped at 80 – 100.

development' ideology to a more complex matrix-like structure of more varied political-economic configurations and more politically sensitive alliances.

Science and technology will play an important role in this emerging, and more complex, global order. In particular, science and technology will continue to drive military *and* commercial capabilities. The hybrid communist-capitalist architecture that has evolved in China and more traditional democratic-capitalist architectures, each have distinctive strengths in terms of science and technology. Market processes are more efficient than bureaucratic planning systems in allocating resources for innovation and technological development. Bureaucratic planning systems are better than markets at allocating resources to address long-term and/or uncertain and risky challenges that markets can't cope with. Consequently, market-based and central planning-based resource allocations tend to *co-exist* and, in combination, form a basis for technological advantage (exemplified by the role of military S&T in the US science and innovation system). Given that the self-regulation of non-military science effectively takes place in civil society, different attitudes towards freedom, intellectual property and indeed the very acceptance of the legitimacy of civil society in some political contexts will in turn impact upon how science operates.

Dual-use concerns (military-civil applications of science and technology) may grow even stronger due to the more complex, and potentially unstable, interplay of communist-capitalist and democratic-capitalist power founded upon S&T capability. These dual use concerns will inevitably influence how tensions between cooperation and competition in international science and technology are managed. In particular, geopolitical tensions may drive a wedge between public interest science and research (which is inherently international in scope and ethos) and technological advance and business innovation – which are at their core matters of competition between nations. Such a policy stance would contrast strongly with current trends to closely couple science policy with innovation policy.

> "geopolitical tensions may drive a wedge between public interest science and research, and technological advance and business innovation – which are at their core matters of competition between nations"

In order to achieve policy legitimacy, this integrated stance seeks to frame the value proposition for public science and research in terms of 'innovation' pay-offs linked to industry competitiveness and long-term productivity growth.

Against this geopolitical backdrop we have challenges that will require either science and technology as part of the solution or policy responses that are informed by research. These challenges, in turn, will tend to require international scientific cooperation. By implication, the era in which international scientific and technological cooperation is most required (in order to address global challenges) will also be the era in which geopolitical tensions that may restrict international cooperation in science and technology will do so even more than in the past.

The challenge is how best to articulate and implement an interoperability-based approach in the emerging global research order with its complex geopolitical sensitivities. Examining this issue requires a more explicit emphasis on the geopolitical realities of international research cooperation and also on the complex contractual and intellectual property management issues faced in forming more agile bilateral and multilateral cooperation relationships when dual-use and/or commercial competition dimensions are present.

*Dr Mark Matthews, FEAST*


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