The University of Wollongong has built its successful research base and reputation through a concerted strategy of focusing on our strengths. We have continued to expand and grow areas where we have traditionally had world-leading research groups. These include information and communications technology (ICT), engineering and the sciences. The high quality of our research in Nanotechnology/materials science has been recognised and strengthened by the award of an ARC Centre of Excellence in Science to a team lead by UoW. More recently, our research effort has been growing in new areas such as functional foods, health services research, Asia Pacific studies and international law.

The following pages convey the excellence of our research in these and other important areas, as well as profiling some of our key research staff.

Clearly, quality people are fundamental to excellent research. UOW attracts and retains outstanding staff through a combination of our strong research reputation and the fact that the local region offers a fantastic lifestyle. Our cohort quality of over 1000 higher degree research students also makes an important contribution to the excitement in our research activities.

The UOW research effort also has a number of distinguishing characteristics. First, it has been underpinned by our capacity to establish effective partnerships with industry and with other research organizations, within Australia and internationally. We have a number of long-standing relationships with steelmakers, telecommunications carriers, pharmaceutical manufacturers and food companies. Our researchers also collaborate with other leading universities around the world.

Secondly, we have been able to develop successful multidisciplinary research teams. Thus Wollongong is a University where scientists talk to lawyers, IT professionals collaborate with creative artists and economists engage with public health practitioners. This is vital because it is research at the boundaries between disciplines that often results in the enigmatic quantum leaps in our understanding.

Finally, building on our reputation for research that makes an impact, we have recently strengthened our capacity to commercialize the results of our research through a partnership with leading Australian university technology company UniQuest. We believe this historic agreement will become a model for collaboration in this important area for the sector.

Professor Margaret Sheil
Pro Vice-Chancellor
UNIVERSITY OF WOLLONGONG
It gives me great pleasure to introduce the University of Wollongong Research Profile, featuring some of the truly remarkable world-class research projects being undertaken by our staff and students.

This profile coincides with the University of Wollongong being ranked among the leading research universities in Australia. The 2006 Australian Good Universities Guide gave UOW a five-star rating in Research Intensity — one of just eight universities in this elite grouping.

This five-star rating is a fitting reward for the major effort that has been made across all Faculties of the University to build on our research strengths and capabilities. We know that our research gives us an important edge, and it is rewarding to have received this recognition.

Research is fundamental to the strength of this University and plays a major role in helping us fulfill the University's mission to explore, develop and apply human and technological capacity for the benefit of its region, the nation and the international community.

Our researchers work on projects that really make a difference to our world and to peoples' lives.

But just as importantly they provide an innovative and fertile learning environment for our students. Academics at the leading edge of research are likely to be inspired – and inspiring – teachers.

The University of Wollongong’s remarkable research record proves that size is no barrier to success. In fact, it can be an advantage as the University consistently outperforms much larger institutions in winning Australian Research Council and other competitive grants. The University has capitalised on its size to create a research environment that facilitates multidisciplinary approaches to research, is focused on outcomes to real problems, and is underpinned by strong partnerships with industry and other R&D organisations.

This publication profiles a cross-section of our research projects, introduces some of our outstanding researchers and demonstrates why they command international respect.

Professor G. R. Sutton
Vice Chancellor
UNIVERSITY OF WOLLONGONG

THE UNIVERSITY OF WOLLONGONG’S FIVE-STAR RATINGS
(2006 AUSTRALIAN GOOD UNIVERSITIES GUIDE):

***** RESEARCH INTENSITY
***** GRADUATE RATING
***** POSITIVE GRADUATE OUTCOMES
***** GETTING A JOB
***** GRADUATE STARTING SALARIES
***** STAFF QUALIFICATIONS
ARC KEY CENTRE FOR ASIA PACIFIC SOCIAL TRANSFORMATION STUDIES (CAPTRANS)
DIRECTOR: DR LENORE LYONS

ARC KEY CENTRE FOR SMART FOODS
DIRECTOR: ASSOCIATE PROFESSOR PETER MCLENNAN

BLUESCOPE STEEL INSTITUTE
PROFESSOR RIAN DIPPENAAR

CENTRE FOR HEALTH SERVICE DEVELOPMENT
PROFESSOR KATHY EAGAR

CENTRE FOR MARITIME POLICY
PROFESSOR MARTIN TSAMENYI

ENGINEERING MANUFACTURING
PROFESSOR CHRIS COOK

GEOQUEST RESEARCH CENTRE
PROFESSOR LESLEY HEAD

INSTITUTE FOR BIOMOLECULAR SCIENCE
PROFESSOR JOHN BREMNER

INSTITUTE FOR CONSERVATION BIOLOGY AND LAW
PROFESSOR DAVID AYRE

INSTITUTE FOR SUPERCONDUCTING AND ELECTRONIC MATERIALS
PROFESSOR SHI XUE DOU

ARC CENTRE FOR NANOSTRUCTURED ELECTROMATERIALS
INTELLIGENT POLYMER RESEARCH INSTITUTE
PROFESSOR GORDON WALLACE

TELECOMMUNICATIONS AND INFORMATION TECHNOLOGY RESEARCH INSTITUTE
PROFESSOR REI SAFAVI-NAINI

OTHER EXTERNALLY FUNDED CENTRES

NATIONAL CENTRE OF EXCELLENCE IN FUNCTIONAL FOODS
PROFESSOR LINDA TAPSELL

CRC FOR INTELLIGENT MANUFACTURING SYSTEMS & TECHNOLOGIES
PROFESSOR CHRIS COOK

CRC FOR WELDED STRUCTURES
PROFESSOR JOHN NORRISH

CRC FOR RAILWAY ENGINEERING & TECHNOLOGIES
PROFESSOR BUDDHIMA INDRARATNA

CRC FOR SMART INTERNET TECHNOLOGY
PROFESSOR FARZAD SAFAEI
AWARDS & HONOURS

FELLOW OF ACADEMY OF ENGINEERING AND TECHNOLOGICAL SCIENCES (FTSE)
Professor Gordon Wallace – Faculty of Science

FELLOW OF THE ACADEMY OF HUMANITIES
Professor Lesley Head – Faculty of Science

NEW SOUTH WALES PREMIER’S PRIZE FOR POETRY (KENNETH SLESSOR AWARD)
The Lovemakers Book One: ‘Saying All The Great Sexy Things’
and was subsequently named the
NEW SOUTH WALES PREMIER’S PRIZE BOOK OF THE YEAR
Later that year it won the
QUEENSLAND ARTS MINISTRY’S JUDITH WRIGHT CALANTHE PRIZE FOR POETRY
Mr Alan Wearne – Faculty of Creative Arts

BULLETIN MAGAZINE SMART 100 (TOP 10 ENVIRONMENTAL THINKERS)
Professor Sharon Beder – Faculty of Arts

BRUCE MCCOMISH PRIZE FOR ECONOMIC HISTORY
Professor Simon Ville – Faculty of Commerce

ELECTED KING CARL XVI GUSTAF PROFESSOR IN ENVIRONMENTAL SCIENCE
Professor Lesley Head – Faculty of Science

AUSTRALIAN SOCIETY OF CERTIFIED PUBLIC ACCOUNTANTS – SERVICE MEDAL AWARD
Associate Professor Michael McCrae – Faculty of Commerce

CHARLES GOELDNER ARTICLE OF EXCELLENCE IN THE JOURNAL OF TRAVEL RESEARCH
Associate Professor Sara Dolnicar – Faculty of Commerce

NSW TALL POPPY AWARD FOR EXCELLENCE IN LIFE SCIENCE, AWARD FROM AUSTRALIAN INSTITUTE OF POLITICAL SCIENCE
Dr Suresh Mahalingam

CHURCHILL FELLOWSHIP
Dr Michael Adams – Aboriginal Education Centre and Institute for Conservation Biology

NSW BIOFIRST AWARD
Professor Mats Olsen – Faculty of Science

AUSTRALIAN CENTENARY MEDAL FOR CONTRIBUTION IN MATERIALS SCIENCE AND TECHNOLOGY ISSUED BY PRIME MINISTER OF AUSTRALIA IN MAY 2003
Professor Shi Xue Dou – Faculty of Engineering

THE BRITISH COUNCIL AND NEW SCIENTIST MAGAZINE SCIENCE WRITING COMPETITION
Ms Rachel Przeslawski (PhD Candidate) – School of Biological Sciences
ALEXANDER VON HUMBOLDT FELLOWSHIP
DETERMINING THE PRESENCE OF LAMININ
AUTOANTIBODIES IN THE AREAS OF
RHEUMATIC HEART DISEASE PATIENTS,
GERMANY NATIONAL CENTRE FOR
BIOTECHNOLOGY
Professor Mark Walker – Faculty of Science

AUSTRALIAN AND NEW ZEALAND INDUSTRIAL
AND APPLIED MATHEMATICS (A DIVISION OF THE
AUSTRALIAN MATHEMATICS SOCIETY) J.H
MICHELL MEDAL FOR OUTSTANDING NEW
RESEARCHER
Dr Mark Ian Nelson – School of Mathematics
and Applied Statistics

2004 FULBRIGHT SENIOR SCHOLAR AWARD
Associate Professor Tony Hulbert – Faculty of Science

2004 AUSTRALIA COUNCIL COMPOSER
FELLOWSHIP IN MUSIC THEATRE
Professor Andrew Schultz – Faculty of Creative Arts

2004 AMERICAN SOCIETY OF CIVIL ENGINEERS,
FELLOWSHIP
Professor Buddhima Indraratna – Civil Mining &
Environmental Engineering, Faculty of Engineering

2004 WORLD CONFERENCE ON EDUCATIONAL
MULTIMEDIA, HYPERMEDIA AND
TELECOMMUNICATIONS, LUGANO, OUTSTANDING
PAPER AWARD AT ED-MEDIA.
Dr Greg Rowland – Faculty of Education

2004 NSW FILM AND TELEVISION OFFICE NEW
FEATURE FILM WRITERS SCHEME GRANT
Associate Professor Gerry Tercotte – Faculty of Arts

2004 INTERGOVERNMENTAL PANEL ON CLIMATE
CHANGE’S (IPCC) FOURTH ASSESSMENT
OF CLIMATE CHANGE
Associate Professor Colin Woodroffe – Faculty of Science.

2004 SIR WILLIAM HUSDSON MEMORIAL AWARD,
RESEARCH INTO RAPID PROGRAMMING OF
ROBOTIC WELDING CELLS.
Alex Nicholson – Faculty of Engineering PhD Student

INTERNATIONAL ESTUARINE RESEARCH
FEDERATION’S BIENNIAL CONFERENCE,
SEATTLE, USA - BEST STUDENT PRESENTATION
Kerylee Rogers - Environmental Science PhD Student

2003 PHELPS’S EDUCATIONAL AWARD,
MONTEREY, NUCLEAR SPACE RADIATION EFFECT
CONFERENCE USA AINSE GOLD MEDAL, 2003
Mr Iwan Cornelius - Physics PhD Gold Medal

2004 MAX PLANCK INSTITUTE FOR
INTELLECTUAL PROPERTY FELLOWSHIP
Professor Christoph Antons – Faculty of Law

AUSTRALIAN RESEARCH COUNCIL DISCOVERY
PROJECT FELLOWSHIPS

AUSTRALIAN POSTDOCTORAL FELLOWSHIP (APD)
Dr Dominic Phelan (awarded 2005)
Dr Theresa Devahayam (awarded 2005)
Dr Sihai Zhou (awarded 2005)
Dr Alexey Pan (awarded 2004)
Dr Nancy Humpel (awarded 2004)
Dr Zaiping Guo (awarded 2004)
Dr Vanessa Haverd (awarded 2004)

AUSTRALIAN PROFESORIAL FELLOWSHIP (APF)
Professor James Hill (awarded 2004)
Professor Mats Olsson (awarded 2004)

AUSTRALIAN RESEARCH FELLOWSHIP/QUEEN
ELIZABETH II FELLOWSHIP (ARF/QEII)
Dr Andrew Minnet (awarded 2005)
Dr Xiaolin Wang (awarded 2005)
Dr Christian Turney (awarded 2004)

2003 SCIENCE AND INNOVATION AWARDS FOR
YOUNG PEOPLE IN AGRICULTURE, FISHERIES &
FORESTRY, NSW AWARD
Dr Wendy Russell - School of Biological Science

ENERGY GLOBE AWARD 2003 2ND PRIZE
CATEGORY WATER
Dr Andrea Schafer and Dr Bryce Richards - Environmental
Engineering UOW, Centre for Photovoltaics Engineering
UNSW
The concern for public health is shifting from dietary deficiencies to excesses – the so-called diseases of affluence. This requires a sophisticated working knowledge of the health benefits of nutrients, how they act and how they can be assured in the contemporary food supply.

Established in 1999 by the Australian Research Council and the University of Wollongong as a Key Centre of Teaching and Research, the Smart Foods Centre (SFC) forms an alliance between the University, the food industry and government. The Centre comprises collaborating scientists, principally within the Faculty of Health and Behavioural Sciences and associated departments, working in conjunction with the food industry. Its aim is to benefit all Australians through nutrition-related research and education, and it plays a key role in training food industry personnel. In 2003, the Smart Foods Centre became the administering centre for the National Centre of Excellence in Functional Foods, an initiative of the National Food Industry Strategy (Ltd), in partnership with CSIRO-Health Sciences and Nutrition, Food Science Australia and the Department of Primary Industries, Victoria.

Food sector research areas at the SFC included proteins and protein-rich foods as fuels and cellular building blocks; fats and oils as fuels; fish and fish oils, with particular expertise in omega-3 research in obesity; heart and muscle function; insulin sensitivity; and blood pressure. With regard to human health and disease the SFC’s strengths extend to nutrition in healthy heart function and muscle physiology, dietary change and energy balance for daily living; and healthy ageing. This basic research combines with translational studies in food habits, consumer issues, food labelling and marketing, where understanding nutrients as components of whole foods underpins the ability to apply research outcomes. Here, translational research is required to ensure effective links between outcomes from one domain of science to another.

Within the SFC, the University has established the first human Whole Room Calorimeter (WRC) in Australia, which will enable researchers and members of the pharmaceutical and food industries working on understanding obesity diabetes and related disorders, to study human metabolism and accurately measure energy expenditure.
THE GOOD OIL ON WALNUTS

The nutritional benefits of walnuts have been understood for thousands of years.

Excavations in France have uncovered petrified shells of walnuts roasted in the Neolithic period more than 8,000 years ago, and inscriptions on clay tablets show that walnut trees were an important feature of the famed Hanging Gardens of Babylon around 4,000 years ago. The Romans considered the nut a food fit for the gods, and planted walnut trees throughout the Roman Empire from as early as 100 B.C.

Modern scientific analysis shows the Romans knew a good thing when they saw one, as walnuts are rich in polyunsaturated fats, Omega oils and vitamins.

Now researchers at the University of Wollongong’s Smart Foods Centre have shown how to harness the nutritional value of walnuts, especially the “good” oils, to help people manage their diet better in the early stages of Type 2 Diabetes Mellitus.

National Centre of Excellence for Functional Foods and former Smart Foods Centre Director Professor Linda Tapsell said the research had demonstrated how a diet rich in walnuts delivered the right kinds of fats and fatty acids that might help the body address one of the problems associated with early stage Type 2 Diabetes – insulin resistance – which hinders the absorption of glucose from the bloodstream into human cells.

“We understood the relationship between insulin resistance and fatty acids, and when we looked at the composition of walnuts we thought that they could be useful in delivering the right kinds of fatty acids. We knew walnuts contained substantial amounts of these fats, so our challenge was to prove that the theoretical benefits were real,” Professor Tapsell says.

The team of dietitians from the Smart Foods Centre and the Illawarra Diabetes Service developed individualised diets for around 60 people with Type 2 Diabetes for the six-month study. The diets were based on the core food groups of cereals and breads, fruit and vegetables, lean meat, fish, low-fat dairy products, oils, avocados, peanut butter and nuts. Each diet in the treatment group included 30g of walnuts (equivalent to around 8-10 nuts) per day.

The diets were carefully modelled to balance all the other dietary factors such as carbohydrates, proteins, calories and fats from the other foods to ensure the benefit was correctly attributed to the walnuts.

“The walnuts took the guesswork out of getting the right fats into the diet. We knew walnuts would deliver,” Professor Tapsell says. “People with Type 2 Diabetes could ask their doctor or dietitian about the benefits of including walnuts in their dietary management.”

Professor Tapsell said the study had been important because it confirmed the theoretical benefits of a certain food.

“Food companies need this kind of research because it assists them in making legitimate claims about the benefits of certain foods. This particular research finding is also useful for doctors and dietitians when they provide advice to people on how to get good fatty acids into their diets.”
The Centre for Health Service Development (CHSD) has undertaken research into methods to improve the management and provision of health services in Australia, with the goal of making a significant contribution to improving funding and delivery. Since 1993, it has conducted around 150 health service research, development and evaluation projects, with budgets ranging from less than $10,000 to $1.5 million. The Centre is self-funded from its project funds and from a NSW Department of Health infrastructure grant to support health research.

In 2003 the CHSD was recognised as one of six research units in NSW of significance because of its track record of innovation and excellence in conducting research in public health, primary health care, and health services research. The Centre was awarded a grant for three years under NSW Health’s Capacity Building Infrastructure Grant (CBIG) scheme, which aims to strengthen the research and development agenda in the health system.

CHSD team members have experience in management, planning and research in health services, community services and consumer organisations as well as being members and chairpersons of intra-government and inter-government committees and organisations. In addition to producing standard academic output, the Centre’s work results in a range of practical advice to a variety of government and non-government agencies and interest groups.

CONTACT  PROFESSOR KATHY EAGAR
DIRECTOR CHSD
EMAIL: chsd@uow.edu.au
WEB LINK: www.uow.edu.au/commerce/chsd/
Why, when you wake one morning and feel unwell, or when your child falls ill in the middle of the night, do you sometimes go to a hospital emergency department and at other times call on an after-hours general practitioner or medical service? Why are emergency departments busy at certain times of the day and not so busy at others?

The Centre for Health Service Development (CHSD), in collaboration with Illawarra Health (IH), is examining why patients attend emergency departments, and whether the number and types of people who use them are influenced by the availability of primary care community health services, such as general practitioners and after-hours medical services.

The study stems from the perception that large numbers of patients attend emergency departments for general practitioner style care. The changes in the volume and the nature of emergency presentations to hospitals is a key area of the Priority Driven Research Program of the Australian Health Ministers’ Advisory Council (AHMAC). This CHSD project, based in the Illawarra and Shoalhaven regions of the south coast of New South Wales, is one of eight across the country covering diverse aspects of emergency department care.

Of course, not all emergency department visits are relevant to the project — there are some patients who should not go to a general practitioner or medical service. Emergency departments have an unquestionable role in trauma and life-threatening situations and this project is looking only at cases where there is a genuine choice between receiving care in an emergency department and at a general practitioner.

There are two parts to the project. The first is a large-scale analysis looking at emergency department attendances in the Illawarra and Shoalhaven in the last six years, amounting to many thousands of database records. The researchers are developing a comprehensive picture of primary care availability and access.

The second phase aims to examine community perceptions about the role of emergency departments, and why patients with primary care health problems choose to attend either an emergency department or a general practitioner.
The Centre for Maritime Policy at the University of Wollongong is the Asia-Pacific region’s leading academic centre for research on issues of national and international ocean law and policy, ocean management and maritime security.

The Centre’s researchers play a key role in helping governments grapple with a wide range of maritime issues such as security, threats of sea-borne attacks by terrorists or pirates, border issues, protection of the marine environment, introduced marine species, illegal fishing and boundary delimitation.

Established in 1994 as a joint initiative between the Royal Australian Navy (RAN) and the University of Wollongong, the Centre played a significant role in the development of the Australian Government’s Ocean Policy and continues to influence the policy process in Australia.

The University of Wollongong, through the Centre for Maritime Policy, offers the only multidisciplinary maritime postgraduate degree program in Australia, and is one of the few universities in the world to do so. It combines aspects of marine policy, law, science and security to offer a genuinely comprehensive and multidisciplinary approach to the study of maritime issues.

Many senior Australian and overseas government officers working on ocean-related policy are graduates of the Centre’s degree program. The Centre also offers regular professional short courses on the Law of the Sea, Maritime Regulation and Enforcement, Regulation of Shipping, Maritime Security Law and International Fisheries Law. In addition, the Centre develops and teaches specialised courses tailored for Government agencies in Australia and overseas.

The Centre has strong linkages with Australian government agencies including the RAN, Environment Australia, the National Oceans Office, the Australian Fisheries Management Authority, Coastwatch, the Department of Defence, the Australian Maritime Safety Authority and the Department of Foreign Affairs and Trade.

The Centre also has a strong international presence, particularly in the Asia-Pacific region where its research and policy development projects range from helping the Indonesian and Philippines Governments resolve fishing rights issues in the Sulewesi Sea, to research consultancies on Ocean Governance for the Asia-Pacific Economic Cooperation (APEC) forum.

It also works closely with overseas governments and international organisations such as United Nations agencies.

“There’s not much that happens in maritime policy in the Asia-Pacific region that we aren’t involved in,” says Centre Director Professor Martin Tsamenyi.
ILLEGAL FISHING AN INTERNATIONAL ISSUE

The dramatic 21-day pursuit across the Southern Ocean by an Australian fisheries patrol boat of a suspected illegal fishing activity by the Uruguayan vessel Viarsa 1 highlighted the high stakes of illegal fishing.

The Viarsa 1 was found to have 85 tonnes of the rare and endangered Patagonian Toothfish – termed the “white gold” of the South Ocean – in its freezers. The vessel had caught the fish off the Heard and McDonald Islands in Australia’s exclusive economic zone, 2,400 km south-west of Western Australia.

Illegal, unreported and unregulated (IUU) fishing is a major problem across the world’s oceans. Not only does IUU fishing deprive nations and their legitimate fishing fleets of economic benefit, it also creates significant problems in the sustainable management of fish stocks and fish habitats. Poachers are not concerned with key scientific issues such as breeding cycles, maintaining breeding populations and setting aside sanctuaries in areas of critical habitat.

The Australian Government’s reaction to the illegal fishing activities by the Viarsa 1 was unequivocal. With the assistance of ships from other nations, it cornered the Uruguayan vessel after a chase through some of the world’s most inhospitable waters and escorted it to Fremantle where it and its catch were formally seized.

The Viarsa 1 incident was a dramatic example of the problems of IUU, which confront all governments concerned with the sustainable management of the world’s fishery resources. IUU fishing can lead to an erosion in the relationship between fishing nations, possible conflict over resource use, the collapse of fishing stocks and the loss of social and economic opportunities for fishing communities.

It was precisely these issues which prompted the Indonesian and Philippines Governments to seek the assistance of UOW’s Centre for Maritime Policy to undertake a three-year research project funded by the Australian Centre for International Agricultural Research (ACIAR) to establish workable policies, agreements and fishing stock management structures between two of South-east Asia’s major fishing nations. Both suffer significant economic and social losses due to IUU fishing, which is estimated to cost the Indonesian economy US$2 billion annually, while the cost to the Philippines is also well over US$1 billion.

IUU fishing is particularly serious for both nations in the Sulawesi Sea, where the two nations have no agreed maritime boundary, but where they share a number of common fish stocks and where there is a high level of illegal foreign fishing.

The Centre started work on the three-year project in mid-2003, and is working to achieve a range of outcomes including greater bilateral cooperation between Indonesia and the Philippines in the absence of agreed boundaries,

- development of policies and legislative framework to address IUU fishing and help the development of sustainable management of fish stocks
- facilitation of capacity building to help the two nations deal with IUU fishing
- development of a “Regional Plan of Action” to combat IUU fishing.
The GeoQuEST Research Centre in the University of Wollongong’s School of Earth and Environmental Sciences brings together outstanding researchers in Geography, Geology and Environmental Science.

They share central interests in Earth processes, environmental change and the interaction of humans with, and impact on, the landscape, fauna and flora. Their research covers a broad range of areas including urban, coastal, coral reef, fluvial and aeolian environments.

The Centre has an international reputation for the quality of its people and facilities and provides a wide range of research and consulting services, working on scales from local to global.

GeoQuEST Coordinator during 2004 Professor Lesley Head specialises in Australian prehistory and environmental change, cultural landscapes, as well as past and present Aboriginal land use. Professor Head will be heading to Sweden as King Carl XVI Gustaf visiting Professor-ship in Environmental Science in August, 2005. Professor Colin Woodroffe, a leading authority in Coastal Geomorphology and GIS will assume leadership of GeoQuest.

The Centre's other academic staff and research students have expertise in:

- Remote Sensing and Geographical Information Systems (GIS) Applications
- Geochronology
- Sedimentology and Stratigraphy
- Geomorphology
- Social and Cultural Change
- International Migration
- Geochemistry
- Palaeoceanography
- Estuarine Science and Management
- Quaternary Environmental Change
- Coastal Evolution and Processes
- Australian Prehistory
- Petrology
- Pollution Studies
- Environmental Management.

GeoQuEST Consulting offers a broad range of services executed by the Centre’s experts using the best technologies available. Services range from thermoluminescence and optical dating, to drilling and coring, GIS analysis, aerial photography and map interpretation, and environmental management.
‘HOBBIT’ DISCOVERY REVERBERATES AROUND THE WORLD

THE SCIENTISTS DISCOVERED A SKELETON OF A ONE-METRE TALL FEMALE AGED AROUND 30 DURING AN ARCHAEOLOGICAL DIG IN LIANG BUA.

Australian and Indonesian archaeologists who found the previously undiscovered species of small human on the Indonesian island of Flores were able to determine when these little people walked the Earth, thanks to the world-class dating work by GeoQuEST scientists from the University of Wollongong.

The discovery was reported by the British weekly scientific journal *Nature* in October 2004, and created a sensation that reverberated around the world.

The *Nature* report raised images of a lost world of “little people” that co-existed with modern humans until relatively recently.

The scientists discovered a skeleton of a one-metre tall female aged around 30 during an archaeological dig in Liang Bua, a large limestone cave on Flores, 600 km east of Bali. They subsequently found other skeletal remains in the cave.

A dating team led by University of Wollongong (UOW) geochronologist Professor Richard ‘Bert’ Roberts from the GeoQuEST Research Centre used a variety of techniques including radiocarbon, luminescence, uranium-series and electron spin resonance to show that the skeleton was around 18,000 years old. The remains of a further seven individuals who lived in the cave from about 95,000 to 13,000 years ago have also been found.

The skeleton, nicknamed ‘Hobbit’ by the excavation team, is now the type specimen for a new human species *Homo floresiensis* – hailed as one of the most significant palaeoanthropological discoveries in a century.

The Indonesian-Australian excavation team was led by archaeologists Professors Mike Morwood from the University of New England and R.P. Soejono from the Indonesian Research Centre for Archaeology, while the UOW GeoQuEST team of Prof Roberts, Dr Chris Turney and PhD researcher Kira Westaway provided its expertise in dating techniques.
The Institute for Biomolecular Science (IBS) brings together a large multidisciplinary team of chemists and biologists from the University of Wollongong’s Department of Chemistry and School of Biological Sciences. The Institute’s program incorporates three key areas of research: antimicrobial agents, diseases of ageing, and cancer. Work on antimicrobial agents is particularly targeted at new antibacterials, antivirals and antimalarial agents, with the problem of antimicrobial drug resistance as a major focus. The area of age-related diseases includes cataracts and neuro-degenerative diseases. The cancer-related research involves apoptosis (the controlled destruction of cells in terms of the growth and development of the disease), as well as new therapeutic strategies for breast and prostate cancers.

IBS’s research programs are underpinned by crucial core expertise in drug discovery, design and synthesis, together with the detection and structural characterisation of biological targets. Long-term goals are to develop new drug leads to address problems of drug resistance in infectious disease and to tackle, in a new and more effective way, diseases associated with ageing.

INSTITUTE FOR BIOMOLECULAR SCIENCE

DRUG-RESISTANT BACTERIA, OR SUPERBUGS, THREATEN TO UNDERMINE DECADES OF ADVANCES IN MODERN MEDICINE.
Drug-resistant bacteria, or superbugs, threaten to undermine decades of advances in modern medicine. For example, there has been a resurgence in the incidence of tuberculosis – there are around three million deaths a year – as well as other bacterial diseases such as those caused by Golden Staph (Staphylococcus aureus).

In tackling the superbug challenge, researchers at the IBS are using a combination of methods: looking to nature using bio-rational and chemo-rational approaches. A possible source of new antibacterials, for instance, is the significant defensive antimicrobial activity in molluscan (snail) egg masses. From another bio-rational perspective, researchers have found that Carissa lanceolata, a plant used traditionally by Indigenous Australians in Western Australia, Queensland and the Northern Territory to treat toothache, is active against Golden Staph. Using a combined bio-rational and chemo-rational approach, new antibacterial agents have also been found in medicinal plants from Lombok in Indonesia.

At the IBS, synthetic compounds are also being examined in an effort to overcome bacteria that are resistant to vancomycin, a traditional last line of therapeutic defence. A natural product from a micro-organism which was discovered in 1956, vancomycin has been used widely since 1958. It interferes with bacterial cell wall formation and the affected cells (with weak cell walls) burst under the osmotic pressure. Vancomycin-resistant bacteria have mutated so that vancomycin cannot disrupt bacterial cell wall synthesis.

In 1986 vancomycin-resistant enterococci (VRE) were first detected in hospitals, and these VRE strains are spreading. Untreatable VRE infections can be life threatening. However, the molecular details of the changes in the resistant bacteria are known, and researchers at the IBS have designed and made new compounds to try to overcome the vancomycin-resistant bacteria.
Founded in 2001, the Institute for Conservation Biology (ICB) grew out of the Australian Flora and Fauna Research Centre and the Centre for Natural Resource Law and Policy. Today it is composed largely of biologists combined with a group of lawyers who are concerned with environmental and natural resource issues.

Research at the ICB has three main themes. The first is fundamental biology, which is mostly in the areas of ecology, physiology and genetics. While much of this research is driven by the desire to test questions of larger biological issues, the work inevitably feeds into conservation biology. For the lawyers, the interest is in legislation as it relates to natural resource management, such as water rights, and hence to conservation. Then there is the interface, where conservation biology and the law meet in an attempt to influence policy and legislation by better informing the debate.

Projects within the ICB span marine and terrestrial ecosystems, with some freshwater systems, as well as a considerable selection of plants and animals and a wide range of organisms. Most of the research undertaken at the ICB requires a variety of approaches even when the question may appear quite simple and fundamental. For example, experimental ecology, behaviour, physiology and genetics may all be employed when looking at the requirements of an organism to exist in a particular place. However, while there is collaboration to some extent, most of the researchers have their own identifiable separate research interests and each of the biologists runs a laboratory with postgraduate students.
ALIEN INVASION: CAULERPA TAXIFOLIA IN AUSTRALIAN WATERS

Biologists have been doing battle in the Mediterranean with the marine invader, Caulerpa taxifolia, for almost 20 years without success. A green seaweed with a hardy disposition which grows profusely, it is now found in five countries and covers an estimated 50,000 hectares of sea floor.

Caulerpa taxifolia was discovered in southern Australian waters in 2000 and its presence has been confirmed in eight locations within New South Wales. It seems likely that infestations are the result of dumping the contents of aquaria into shallow coastal sites, with subsequent dissemination to other locations via commercial or recreational activities such as boating and fishing.

ICB biologist, Associate Professor Andy Davis, says that another difficulty in controlling the spread of Caulerpa taxifolia is that it propagates asexually. “When pieces break off they can disperse, reattach and form a new infestation away from the original population — the tiniest fragments are capable of developing,” he says. “Manual or mechanical removal of the pest is likely to further its spread. Furthermore, the fronds are capable of surviving out of water for a period of time — such as on the nets of commercial fishers or the anchor lockers of recreational fishermen.”

New South Wales Fisheries, in collaboration with research groups at several universities in the state, are working on reducing the spread of Caulerpa taxifolia and investigating how to control it. Experiments at the ICB confirm that several large and common herbivores — particularly large molluscs and common sea urchins — consumed extracts of the alga in feeding trials.

“Unfortunately those species which do consume it readily, generally avoid it if other algae are available,” Davis says. “However we are investigating an additional avenue which is the use of specialist herbivores as potential biological control agents.”

“Specialist herbivorous insects have already been used successfully with some invasive terrestrial plants and small, saccoglossan molluscs are specialist feeders on Caulerpa Taxifolia for example. NSW Fisheries have adopted another control mechanism to halt the invader — the application of a thick layer of granulated pool salt which delivers an osmotic shock that usually proves fatal to the alga.”

“It’s recognised that there are still significant gaps in our understanding of the biology of this invader, including its ecological impacts on native species and they are a focus of our ongoing research at the ICB,” says Associate Professor Davis.
INSTITUTE FOR SUPERCONDUCTING AND ELECTRONIC MATERIALS

“ENERGY IS THE SINGLE MOST CRITICAL FACTOR AFFECTING WORLDWIDE PROSPERITY.”
Energy is the single most critical factor affecting worldwide prosperity. The current science base cannot meet the high demands for energy in light of the likely depletion of natural energy sources and the increase in the world population.

To meet this challenge, the Institute for Superconducting and Electronic Materials (ISEM) focuses on the establishment of interdisciplinary research programs on energy materials and technology, including energy generation, conversion, efficiency, transmission, storage and conservation.

From a single research program on superconductivity in 1994, the Institute's work has evolved into six projects including applied superconductivity, energy storage materials (lithium batteries and hydrogen storage), spintronics, thin film technology, Terahertz and thermionics, and nano-materials.

The ISEM team consists of a range of well-established researchers working in world-class laboratories. The fundamental work that they undertake will enable Australian researchers to achieve revolutionary advances in the technologies that underlie solar power, wind turbines, hydrogen energy, fuel cells, batteries, flywheels, electric power transmission and electric vehicles, with nano-materials and nanotechnology at the core of these advances.

INNOVATIVE RESEARCH LEADS TO A CHEAPER AND MORE POWERFUL MRI SCANNER

Magnetic resonance imaging (MRI) machines play a vital role in modern medical diagnosis. They produce a 3D image of a patient’s body, allowing doctors to pinpoint signs of cancer or a stroke, for example.

The heart of MRI is the superconducting magnet. Currently MRI machines are built using conventional niobium titanium superconductors which need to be cooled with extremely expensive liquid helium.

Recently, the Director of the ISEM, Professor Shi Xue Dou and his research team have made an important advance in their work. Thanks to nanotechnology, they have created a new superconductor using magnesium diboride. The invention has enabled them to develop superconductor wires that can carry a two million ampere current at liquid hydrogen temperature, three times that of copper wires of the same diameter. The new technology could allow an MRI scanner to operate at higher temperatures and with a higher magnetic field.

“This means the next generation of MRI machines will be much more powerful and much smaller than the current ones,” says Professor Dou. “There would no longer be the need for liquid helium cooling. The MRI scanner could have an electrically driven cryocooler which could reduce the running cost by 75 per cent. And by slashing the cost substantially, the new technology would in turn deliver benefits to patients.”

“This emerging superconductor has great potential for various practical applications, including magnets for MRI machines,” says Professor Dou. “It can also be used for power cables, motors, energy storage, generators and transformers.”

Leading groups at Los Alamos National Laboratory, the National High Magnetic Field Laboratory in Florida, the University of Wisconsin, the University of Geneva and Ohio State University have verified the ISEM’s breakthrough. Already, ISEM’s industry partner, Hyper Tech Inc., has taken the invention to the production stage, making hundred metre long wires, which can be used to construct the magnet coil.

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RESEARCH STAFF PROFILES

CLIMATE CHANGE: TREES REVEAL SECRETS OF THE PAST

Most people’s interest in the weather doesn’t extend much past what it will be like next weekend. University of Wollongong scientist Dr Chris Turney likes sunny Sunday afternoons as much as anybody, but he’s more interested in what happened 50,000 years ago. That information, Dr Turney says, can help scientists predict climate change and what impact it might have on the modern world.

British Dr Turney is a palaeoecologist and an international authority on the study and carbon dating of ancient plants and fossils, and how they reacted to their environment. He says these ancient plants reveal important information about how the world’s climate changed tens of thousands of years ago. That information can be directly applied to the modern world and our current concerns about the effect of climate change, and those concerns, he says, are more than justified.

“The last Ice Age peaked 20,000 years ago and ended 11,500 years ago when the world hit the present-day climate conditions,” Dr Turney says. “But at the end of the Ice Age, the world suddenly became several degrees warmer in a few years. The danger of the world again shifting into a whole new climate state is that you can’t go back – once it happens it is here to stay.”

Part of Dr Turney’s current work is dating wood from kauri trees that have been unearthed in peat bogs in the northern tip of New Zealand’s North Island. Some are more than 100,000 years old. With Dr Turney determining their age back to 60,000 years using a pioneering method of carbon dating, he and New Zealand colleagues can then study the annual growth “rings” on the trees and determine what the weather was like during the life of the tree.

“There’s up to 2000 years of climate history captured in those rings,” Dr Turney says. “These are trees that grew through the Ice Age, and they are perfectly preserved. By determining their age and looking at the size of the rings we can get a handle on what was happening at that time regarding things like temperature and precipitation. “Kauris are very climate sensitive, which makes them good trees for us to work on. We can compare that to what is happening to modern kauris. It is exciting stuff because it helps us understand what happened in the past, and puts it into context of the present and future.”

Linking in with past climate changes, Dr Turney is using his expertise in carbon dating to date human evolution, migration and colonisation in Australia and Southeast Asia. Most recently, Dr Turney was involved in the discovery of Flores (Indonesia) of the new pygmy-sized and ancient-looking species of human, Homo floresiensis (popularly known as “the Hobbit”) where he led the carbon dating which gave the spectacularly young age of their existence as 13,000 years ago. “The find was totally out of left field,” Dr Turney says. What was almost as spectacular was that in geological terms they were living yesterday. Dr Turney’s work is being continued in Flores with the rest of the team to determine when the species arrived in Flores and whether any populations survived more recently.

Dr Turney joined UOW’s GeoQuest Research Centre in the School of Earth and Environmental Sciences in 2004. He is working under an Australian Research Council Queen Elizabeth II Fellowship which gives him the opportunity to join a team he describes as “world-class”. 

“THE DANGER OF THE WORLD AGAIN SHIFTING INTO A WHOLE NEW CLIMATE STATE IS THAT YOU CAN’T GO BACK – ONCE IT HAPPENS IT IS HERE TO STAY.”
Democratic reform in Indonesia since the collapse of the Soeharto Government in 1998 has provided a growing range of opportunities for Indonesians to participate in shaping their country. As the Indonesian Parliament has been opened up to popular representation and participation, so has the nation’s print and electronic media experienced greater freedom and increased commercialisation. This, in turn, has meant that greater global cultural influences have come into play.

Professor Philip Kitley, Head of the School of Social Science, Media and Communication at the University of Wollongong’s Faculty of Arts, is researching the effects of these influences and freedoms on Indonesian society. His research, entitled ‘From Mass to Public: discourses and representation of popular sovereignty in Indonesia,’ follows Professor Kitley’s long-term interest in Indonesian culture after he served as Cultural Attaché to the Australian Embassy in Jakarta for a number of years in the late 1980s.

“Previously Indonesian citizens were only vaguely represented (in Parliament) and not strongly involved in the political and cultural development of their nation, which largely came from the top down,” Professor Kitley says. “However, since President Soeharto resigned and the reform period started there has been a growing range of opportunities for Indonesian citizens to get involved.”

Professor Kitley believes this new era of democratic representation and greater communication between Parliament and the people through websites and other electronic methods, as well as new freedom of information laws and greater access to a range of television influences, means Indonesians are better informed and more able to participate in nation building than in the past.

“The research is looking for evidence of a shift in the role of Indonesian citizens in cultural development (as a result of these changes),” says Professor Kitley. “For example, during the 2004 elections we looked at how the campaign was conducted and how greater freedom of the print and electronic media saw a new style of campaigning, with the media much more involved than in the past.” The research findings are incorporated into the Faculty’s Bachelor of Communication and Media Studies and for students taking a Communications major in their BA. “We’re bringing an understanding and knowledge of media in neighbouring countries as an important ingredient for students undertaking these courses. It’s important for our students’ understanding of Australia’s place in the world that we draw examples from the region as well as from Australia or the United States.”

THE EVOLUTION OF SEX AND THE AGEING PROCESS

Mats Olsson

Two areas in biology which have intrigued every generation from Aristotle (c. 300 BC) to modern times are the evolution of sex and ageing, probably because of their dramatic influences on human life. Still, our understanding of each of these phenomena is superficial to say the least, and we have even less knowledge about the degree to which they may be interconnected.

Mats Olsson, Professor of Evolutionary Ecology in the School of Biological Sciences at the University of Wollongong, has spent the last two decades researching evolutionary ecology and genetics, using reptilian and amphibian model systems.

“One of the most important insights from this research,” says Professor Olsson, “is the value of pluralism — the gains in terms of understanding evolutionary principles from integrating biochemistry, behaviour, genetics, and population ecology.” With this multidisciplinary approach, and using lizards as models, Professor Olsson is currently conducting a research program that targets the perennial questions — the evolution of sexual reproduction, in particular its potential genetic benefits, and ageing. He says that in order for evolution to direct the ageing path through an organism’s life, there needs to be different inherited processes, which may be set as far back as fertilisation, for example through mate choice.

“Recent work suggests that the key can be found in reproductive cell recognition at a membrane molecule level.” This implies that when females mate with several males prior to ovulation, the probability of paternity may be biased towards males that will provide the ‘best’ genetic contribution to the female’s offspring. If, indeed, there is this kind of selection ‘in the wild’ serving as a filter against poor genetic combinations, we need to understand if bypassing it will lead to complications in the case of assisted reproductive medicine for example,” Professor Olsson says. “Research suggests that genes governing the immune system could be one of the factors influencing processes as early as fertilisation, and only the future will tell how this will affect ageing.” Professor Olsson’s project will, however, provide vital insights into the link between fertilisation bias, genetic quality of offspring, and the ageing process.
DR GREG SCHEIMER

TUNING MUSICAL APPLICATIONS FOR WIRELESS INTERNET

Tuning systems have a long history that predates the invention of Western musical notation. Much of this historical legacy gradually became inaccessible with the adoption of a single system based on 12 equal divisions of the octave. This system, however, does not support the microtonal diversity found in tuning systems used by the ancient Greeks and Persians; by classical musicians from the Middle East, India and China; or by folk musicians from many parts of the world.

The pocket gamelan project, devised by Dr Greg Schiemer from the Faculty of Creative Arts, uses mobile phone technology to explore these tuning systems. “Today’s hand-held computing devices offer the promise of new musical applications that represent a radical departure from computer music as it first developed in the 60s,” he says. “I want to develop musical applications that will take advantage of this. Electronic musical instrument designers need to recognise that a performer cannot afford the time it normally takes to master an electronic instrument because the technology is likely to change. Generic hand-held instruments, like mobile phones, provide a solution to this problem. They are easy to play and quick to learn,” says Dr Schiemer. “These instruments will be ideal for performances where a musician’s focus is less on individual virtuosity and more on the quality of ensemble interaction. I have chosen the term ‘gamelan’, the name for Indonesian tuned percussion ensembles, to represent the kind of musical interaction expected.”

In the pocket gamelan, each member of the ensemble will create sound locally on their handset to produce a combined sound made up of dozens, possibly hundreds, of handsets. Eventually the project will accommodate another scenario where ensemble members can affect the sound on adjacent handsets, and yet another where concert-goers may be asked to turn on their mobile phones in order to contribute to the musical outcome. “The project,” says Dr Schiemer, “will provide new avenues for exposing the general public to the rich legacy of global music and, with the help of the mobile phone, will allow them to perform a new music derived from that legacy.”

A SUSTAINABLE WATER TREATMENT SYSTEM

DR ANDREA SCHÄFER

Many communities in the world are living without good quality drinking water and without the electrical power necessary to purify water. Sources of drinkable water vary – for example, in outback Australia the majority of Indigenous communities rely on ground water, while the Gulf countries in the Middle East obtain 95 per cent of their drinking water from oil-powered units which desalinate seawater. As the sources of drinking water vary, do the necessary treatment processes.

Dr Andrea Schäfer from The School of Environmental Engineering at the University of Wollongong and Dr Bryce Richards at ANU, are collaborating on the Reverse Osmosis Solar Installation (ROSI) project, focusing on the development of a solar hybrid membrane system. "The majority of systems treating high-salinity sources — such as seawater — use reverse osmosis (RO) membranes which operate at extremely high pressures, with pumps consuming large amounts of energy," says Dr Schäfer.

"Nanofiltration (NF) membranes on the other hand, have significantly lower operating pressures, a good salt rejection for drinking water purposes and trace contaminant removal as good as, or better than that of RO. In remote communities which have access to water with low salt content — such as ground, surface or tank water — using NF may be sufficient. “By optimising the membrane selection, depending on the water quality, considerable energy can be saved and drinkable water output increased.”

The research focuses on the removal of contaminants, such as arsenic, from water supplies; while bacteria and viruses are reliably removed in the process. With its lower power requirements, solar, or photovoltaic, panels will be used in the ROSI project to convert sunlight directly into electricity. It is also possible to connect a solar tracker to the system, so that the panels point directly at the sun throughout the day, increasing the power generated by at least 30 per cent.

The ROSI team is collaborative and multidisciplinary, combining membrane and mechatronics experts from the University of Wollongong, and a photovoltaic, or solar energy, expert from the Australian National University. The project won second prize in the Water Category at the 2003 Energy Globe Award, a global sustainability award, and is undergoing commercialisation.

"BY OPTIMISING THE MEMBRANE SELECTION, DEPENDING ON THE WATER QUALITY, CONSIDERABLE ENERGY CAN BE SAVED AND DRINKABLE WATER OUTPUT INCREASED.”

“TUNING MUSICAL APPLICATIONS FOR WIRELESS INTERNET

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PIRATES BEWARE: INTELLECTUAL PROPERTY RIGHTS AND ACCESS TO PLANTS, ARTWORK AND OTHER FORMS OF TRADITIONAL KNOWLEDGE  PROFESSOR CHRISTOPH ANTONS

As strange as it may seem, for a short time extracts from the Indian neem tree were patented in Europe, and rice similar to Basmati is produced under the Texmati label. It’s notorious cases such as these underline the importance of intellectual property rights with regard to the appropriation of traditional plant materials and their usage by pharmaceutical and biotechnology companies.

The relationship between traditional knowledge and intellectual property rights doesn’t stop with plants, however. Traditional information is very commonly in the form of a song, a story or a dance; cultural expressions encompass all manner of things from paintings and sculptures to handicrafts, calligraphies and fabrics.

Professor Christoph Antons is the Professor of Comparative Law, Director of the Centre for Comparative Law and Development Studies in Asia and the Pacific; and a QEII Fellow of the Australian Research Council (ARC). He is conducting a research project focusing on traditional knowledge and intellectual property, comparing current approaches in Australia, Indonesia and the Philippines and looking at possible legal policies for the three countries. “It is pertinent in relation to cultural expressions, such as the use of Aboriginal symbols in Australia,” Professor Antons says, “and it also covers the production of cultural materials — often in the form of tourist merchandise — in other countries. For example, items which originate in northern Australia, such as didgeridoos, are reproduced in Vietnam and Indonesia. The Balinese, have a reputation for copying so-called ‘native materials’ from all over the world as well as other parts of Indonesia.”

“What is needed,” says Professor Antons, “is information about how indigenous and local communities themselves administer their traditional knowledge, which means interdisciplinary research involving law and social science.”

UNDERSTANDING VOLUNTEERING MOTIVATIONS IN A MULTICULTURAL COMMUNITY  ASSOC PROFESSOR SARA DOLNICAR

Volunteer work in Australia has an estimated value of $42 billion per annum, with 4.4 million people contributing 704 million hours to the benefit of the community. However, volunteer-based organisations increasingly face recruitment problems, especially in a culturally diverse country like Australia.

Associate Professor Sara Dolnicar, from the University of Wollongong’s School of Management & Marketing is conducting a research project which aims at gaining insight into the volunteering market in a multicultural society in order to help volunteer-based organisations target different groups within the community. The project is being undertaken in co-operation with Wollongong City Bushcare, a program which commenced in 1993 with the aim of encouraging and supporting community participation in the conservation and restoration of Wollongong’s natural areas. The future success of the Bushcare program lies in the continued interest and participation of the local community and, at present, the hurdle to its growth lies in the fact that Wollongong is home to around 60 different ethnic groups. It is, therefore, an extremely heterogeneous community, reflecting a wide range of cultural and personal values.

The project initially involves an extensive explorative phase in order to develop a theoretical model of what motivates volunteers. It could be, for example, that some members of the community will have a high interest in “protecting natural resources for future generations”, while others may be more concerned with creating a ‘family-friendly environment’. The second phase is a large-scale survey analysing the volunteer group and potential volunteer group in the Wollongong area, identifying who the potential competitors for volunteer time are, and looking at possible avenues for increasing participation in Bushcare. “Through an improved understanding of what can motivate members of the community to participate in volunteer work, the local Bushcare unit will be given a powerful tool to communicate with its community,” says Associate Professor Dolnicar. “By improving communication a higher number of volunteers could be recruited to the program, leading to measurable results for the conservation of Wollongong’s natural heritage.”

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“IT IS PERTINENT IN RELATION TO CULTURAL EXPRESSIONS, SUCH AS THE USE OF ABORIGINAL SYMBOLS IN AUSTRALIA.”
The Intelligent Polymer Research Institute (IPRI) at the University of Wollongong has established an international reputation for its work at the cutting edge of intelligent material systems and nanotechnology (microscopic manufacturing). The Institute together with partners at Monash University Bionic Ear Institute has recently been awarded an ARC Centre of Excellence in Electromaterials Science.

Professor Gordon Wallace and his team at IPRI are considered world leaders in their research into the ability of Inherently Conducting Polymers (ICPs) or carbon nanotubes to act as sensing and actuating elements in intelligent materials.

Researchers work with chemicals in the nano-domain (that is, with particles as small as one billionth of a millimetre) where electronic conductivity is vastly higher than in larger structures. Their challenge is to make materials at these dimensions and assemble them into larger structures that retain the special characteristics of the nanocomponents while improving their functionality.

The Institute has developed a range of practical applications for these intelligent materials. For example the IPRI’s artificial muscle glove, developed to assist in the rehabilitation of patients recovering from trauma or surgery to their hand, uses in-built fibres as artificial muscles to simulate contracting muscles which activate the hand and aid the rehabilitation process.

IPRI is developing garments and equipment with the ability to detect harmful chemicals, including a welding helmet with a sensor that emits an alarm if it detects toxic fumes.

IPRI has strategic links and alliances with other research institutions in the United States, Japan, Korea, Italy, Ireland and the United Kingdom, and a network of commercial partners that help turn research breakthroughs to practical applications.
Imagine a paint with special properties that could convert solar energy into electricity for your home, or clothing woven with plastic solar cells that could turn a person into a walking, talking power-generating source.

In the world of intelligent polymers, these and many other things are not just possible, they are in the development phase.

Researchers at IPRI are developing more flexible alternatives to the traditional silicon cells which are currently used to convert solar energy into electricity.

IPRI Director Professor Gordon Wallace says plastic solar cells could be inserted into energy-generating paint or woven into textiles that could then be made into garments that convert sunlight into electricity. He says the US Army is one end-user interested in garments that generate electricity. They would allow someone in a remote area to generate their own electricity to run a laptop computer or cook food.

“There is a whole new area of electronic textiles that has emerged over the last couple of years,” says Professor Wallace. “Sensors are being built into textiles, for example, that can monitor the environment and the textile then actually changes in response to that environment. An example is a wearable prosthetic glove, which we are working on with Royal North Shore Hospital.”

“All of these functions require energy. It’s one thing to make an electronic textile but it’s not much use if you have to plug it into the mains or you have to carry a battery around with you.” Professor Wallace says. “The ultimate goal is to be able to generate the energy from other sources.”
The Telecommunications and Information Technology Research Institute (TITR) at the University of Wollongong is the largest university-based information and communications technology research centre in the Southern Hemisphere.

The work of researchers in TITR has been a key driver in the University developing an international reputation in ICT research, and the New South Wales Government declaring Wollongong a Centre of Excellence in this field. The Institute’s two primary objectives are to carry out leading edge research and development into technologies and applications of future multimedia information communication and services, and to use its expertise and reputation to help establish the Illawarra Region as the ICT hub of New South Wales.

The Institute is a leading research partner in two major Cooperative Research Centres – the CRC for Smart Internet Technology which develops and commercialises key technologies for next generation Internet, and the CRC for Desert Knowledge which aims to develop advanced networks and information communication services to support thriving economies in Australia’s desert regions.

TITR has strong research collaborations with major national and international universities, research institutes and companies in the area of information and communication technologies, and incorporates the Nortel Networks Centre of Excellence in IP Telephony, located on the UOW Campus.

TITR fosters interdisciplinary research and spans the two Faculties of Informatics and Education. It also has close collaboration with UOW’s Digital Media Centre. The Institute includes over 50 academic staff and more than 60 postgraduate students (mostly at PhD level). TITR is made up of the following research centres:

- Audio, Signal Processing and Multimedia Delivery Management
- Emerging Networks & Applications
- Information Security
- Interactive Learning Environments
- Photonics and Electronic Signal Processing
- Visual Information Processing and Content Management
- Wireless Research Group
- Wireless Technologies Lab

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Cryptography may date back 2000 years to the Roman Empire, but it has never been more widely applicable than in the electronic world of the 21st Century. Since Roman Emperor Julius Caesar used secret codes to hide important military information in his dispatches between Rome and his generals in the field, cryptography has been used for 20 centuries by successive generations of government and military leaders as a means of protecting their communications from unfriendly eyes.

The situation changed dramatically in the 1970s with the advent of computers and later the Internet. Advances in E-commerce and widespread use of services such as electronic mail and, in more recent years, the world-wide web, has made the protection of information and the privacy of individuals of central concern.

Researchers at the University of Wollongong’s Centre for Information Security, one of the research Centres in TITR, are conducting research into a range of security technologies for providing security and privacy for the future electronic world. Institute Director, Professor Rei Safavi-Naini, an international expert in information security, says the management of rights in future internet applications will be extremely important.


“At the Institute we are conducting world-class research into areas such as digital rights management and privacy rights management systems,” Professor Safavi-Naini says “Our researchers are producing cutting-edge results and our work has been supported by companies such as Motorola and Telstra. It is also supported by the Smart Internet CRC.

“Digital content such as images or video clips, are easy to copy and illegally distribute, and so it is crucial to provide protection against pirate copies and illegal distribution. In the last nine years we have been working on a range of technologies such as digital watermarking and traitor tracing, and more recently on Digital Rights Management (DRM) systems. These technologies will enable owners of the content to control unauthorised use of electronically transmitted material.”

“Digital watermaking embeds an invisible mark inside an object which can be later recovered and used as a proof of ownership, or as evidence for the integrity of the content. Traitor-tracing systems refer to techniques that allow the tracing of people who have mis-used their rights and have constructed a pirate copy of content.”

“An important issue is balancing the rights of the creator (of digital material) against the rights of the users, and ensuring that ‘fair use’ of the content is honoured,” Professor Safavi-Naini says.

“Another huge concern of users is breach of their privacy rights. We are developing technologies that allow people and enterprises to describe their privacy needs and be assured that the systems give them a guarantee of privacy.”
Our lives depend on manufactured goods, whether it be for housing, medical care, steel for cars and bicycles, aluminium alloys for aeroplanes, or textiles for clothes. Almost human activity relies on manufactured goods in one form or another.

Engineering Manufacturing at the University of Wollongong carries out research to improve manufactured products and manufacturing processes in a never-ending quest for greater accuracy, greater economy, improved performance and higher quality. For example, researchers are involved in:

> finding new ways of improving the quality of steel:
> developing methods to ensure quality of electricity supply is maintained to manufacturing processes
> helping Boeing to manufacture the next generation of aircraft
> assisting industry with its materials handling problems
> developing highly accurate machines and controls to assist surgeons in operations
> developing new actuators and sensors to improve control over fine operations and precision machines
> improving more accurate and ‘intelligent’ robots.

This research covers the full spectrum of disciplines, such as mechanical, mechatronic, electrical and computer engineering, which require physics and mathematics to understand and describe the fundamental theories underlying practical problems. It aims to design and develop the mechanisms, high-speed controls and computer systems necessary for modern manufacturing. It is supported by research grants from industry and from the Federal Government. Engineering Manufacturing also interacts with a number of universities and research institutes internationally.
ROBOTIC DRILLING AND ASSEMBLY OF AEROSPACE MATERIALS

“AN AUTOMATIC SYSTEM NEEDS TO MEET THE REQUIREMENTS DIRECTLY RELATED TO THE NATURE OF THE MATERIAL BEING DRILLED, IN THE SAME WAY THAT AN OPERATOR DOES... WE ARE TRYING TO PUT ‘KNOWLEDGE’ INTO THE SYSTEM.”

Assembling an aeroplane is time consuming and costly. Drilling thousands of holes, for example, on a tight tolerance, where both the size of the holes and their positioning needs to be exact, involves the use of large, dedicated jigs — devices that guide the drill to ensure uniformity.

Currently, drilling is performed by skilled operators who are specially trained to drill carbon composites. Inevitably, human fallibility can result in quality problems such as oversized holes, fibre breakouts from the composite, and premature tool wear. The aircraft industry has a significant interest in providing automated assistance to its personnel to improve productivity and consistency and this has motivated a Cooperative Research Centre for Intelligent Manufacturing Systems and Technologies (CRC IMST) project.

The intelligent end effector project is a collaboration between the University of Wollongong, Boeing Hawker de Havilland, the University of NSW, RMIT, the University of SA, and Marand Precision Engineering. The major challenge is to provide a low-cost and flexible automation solution, or robot, for the drilling and assembly process by eliminating the expensive and cumbersome jigs and fixtures currently used, while still maintaining the high dimensional tolerances required.

Marta Fernandes, who is part of the project team at the University of Wollongong, is working on the development, design and construction of a dedicated test bed for drilling, which is fully automated and controlled by a computer.

“An automatic system needs to meet the requirements directly related to the nature of the material being drilled, in the same way that an operator does, says Ms Fernandes. “We are trying to put ‘knowledge’ into the system. There are many factors to account for, such as the properties of carbon fibre, the state of the drill bit and the required hole tolerances for each application.”

Ms Fernandes’ research is one piece of the puzzle where using a robot can guarantee drilling accuracy. Other research at the University of Wollongong has recently demonstrated that a robot’s accuracy can be improved to better than industry standard using the innovative intelligent end effector. These concepts are now reality at Hawker de Havilland and work is redirected at extending the automated solution to other difficult tasks around the plant.
Bluescope Steel Metallurgy Centre was created by an alliance between BlueScope Steel and the University of Wollongong in 1995, fostering research collaboration between academia and industry. The Centre focuses on research outcomes, development of research capacity, and the fostering of an awareness of steel research in the national and international arena. In this capacity it provides opportunities for academic staff to play a greater part in supporting the local steel industry, and for technologists from industry to contribute to academic development. It also gives students access to the industry, as well as giving them advanced educational opportunities in steel products and processes.

Since 1997 the Centre has conducted research on 42 competitive grant projects with a total budget of $8.92 million. Research activities have been conducted in several key areas focussing on the changing needs of BlueScope Steel as the company has responded to changes in its commercial environment. The Primary Processing Program has focussed on iron and steel making processes as well as associated process technologies. The Casting and Rolling Program has concentrated on thin strip continuous casting technology, thermo-mechanical processing, and steel product development. The casting part of this program contributed to the development of the recently commercialised thin strip casting process and will now focus on the physical metallurgy of thin strip cast steel. The Coatings Technology Program investigates the basic scientific and technological issues underpinning future advances in metal and polymer coating of steel.

The Centre is multidisciplinary, encompassing physical and process metallurgy, mechanical engineering, polymer science, chemistry, and mathematical modelling. It has established strong and focussed research groups and has attracted a talented staff not only to the Centre, but also to the associated teaching disciplines.

THE ADHESION OF PAINTS AND LACQUERS

These teams have built a specialised equipment infrastructure, which is specifically tailored to the needs of the steel industry. The infrastructure is unique in Australia and is shared by both university and industrial researchers.

Two major applications of flat rolled steel are building materials (galvanised steel and pre-painted steel) and packaging products (tinplate). In these applications, polymer coatings – paints and lacquers – are used for decorative purposes and to protect the metal substrate from corrosion. Reliable adhesion of the organic coating to the substrate is therefore very important. For example, a consumer would be unimpressed if the paint on their new steel roof began to peel off or if they opened a can of food to find the lacquer in the food rather than on the inside of the can.

The Bluescope Steel Metallurgy Centre is conducting a research program on polymer coatings, which is focused on improving our understanding of the mechanical properties of the coatings, with particular emphasis on adhesion. The research team is concerned not only with the question of adhesion to the metal substrate, but also with the adhesion of contaminant particles to a painted surface. Such contamination tends to discolour buildings very rapidly, particularly in tropical areas, so contamination-resistant paint formulations are an important feature of their research.
SINCE 1997 THE INSTITUTE HAS CONDUCTED RESEARCH ON 42 COMPETITIVE
GRANT PROJECTS WITH A TOTAL BUDGET OF $8.92 MILLION.

BLUESCOPE STEEL
METALLURGY CENTRE

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COOPERATIVE RESEARCH CENTRE FOR WELDED STRUCTURES

Welding is one of the most commonly used manufacturing processes. It is essential for the fabrication of a wide range of products from the micro circuits used in computers to aircraft engines, super tanker hulls, bridges and buildings. Even the exploitation of Australia’s rich mineral reserves depends on welding for the construction and maintenance of mining equipment and infrastructure. Progress in welding technology is made possible by process developments which improve productivity and reduce costs, and these developments are underpinned by a thorough understanding of the physics of the processes.

The Cooperative Research Centre for Welded Structures, of which the University of Wollongong is a key research partner, is an affiliation of 13 bodies sponsored by the Australian Federal Government. The Research Centre offers student scholarships for many of its tactical research projects and students benefit from input from an industry supervisor or industrial involvement.

The Centre’s numerous projects include:

EVEN THE EXPLOITATION OF AUSTRALIA’S RICH MINERAL RESERVES DEPENDS ON WELDING FOR THE CONSTRUCTION AND MAINTENANCE OF MINING EQUIPMENT AND INFRASTRUCTURE.
RESEARCH CENTRE FOR RAILWAY ENGINEERING AND TECHNOLOGIES

AUSTRALIA'S RAILWAY INDUSTRY IS CURRENTLY REINVENTING ITSELF TO REGAIN ITS STATUS AS A Viable ALTERNATIVE FORM OF LAND TRANSPORT. ONE OF ITS MAJOR CHALLENGES IS TO CREATE A COMPETITIVE EDGE IN THE MARKET THROUGH IMAGINATIVE IDEAS, NEW TECHNOLOGY AND INNOVATIVE LEADERSHIP.

A key initiative in achieving this was the establishment, in 2001, of the Cooperative Research Centre (CRC) for Railway Engineering and Technologies, the first CRC aimed specifically at transport. A collaborative venture between Australia’s major railways, industry and six universities around the nation, it gives Australia’s railway industry a truly national focus for research and consultancy services. The Centre has also established associations with international rail research bodies such as UIC – the International Union of Railways and British Rail, as well as several universities.

Research at the University of Wollongong focuses on innovative automated track maintenance and upgrading technologies aimed at improving the integrity of track structure, which is essential to safe and reliable rail operation. To achieve this, researchers are evaluating the geotechnical properties of fresh and recycled ballast with effective use of geosynthetics to achieve technological advances in modern track design. After designing and constructing several unique, large-scale triaxial rigs with dynamic actuators to simulate rail track conditions, they have established an innovative way of stabilising tracks to cater for high-speed trains that carry heavy loads. Researchers are also developing automated inspection systems with the ability to detect rail breaks; investigating track dynamic response with a special reference to pre-stressed concrete sleepers; and optimised design of rail joints. These investigations will reduce construction, upgrading and maintenance costs as well as increase rail productivity by minimising inspection and maintenance time.

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The Australian manufacturing sector is continuously monitoring, absorbing and adapting new technologies and techniques for industry. The Cooperative Research Centre for Intelligent Manufacturing Systems & Technologies Limited (CRCIMST) is a world-class centre for the development and application of intelligent manufacturing systems and supporting technologies for the economic benefit of Australian industry and society.

CRCIMST consists of five universities, 13 manufacturing companies and the CSIRO-MS&T, with the aid of Commonwealth Government grants and matching contributions from the partners. By working with its partner organisations, the Centre is able to guide and direct the creation and delivery of educational activity relevant to the current and future needs of the manufacturing community.

The Centre’s multi-disciplinary team at the University of Wollongong is comprised of electrical, mechanical, mechatronics and computer engineers. Their research focuses on the development of new sensors; new mathematical models for processes, such as hole drilling and machine vibrations; the creation of new mechanisms such as robots and robot grippers; and software and hardware for high-speed computer control of industrial machines, processes and operations.

The CRCIMST’s international linkages and programs enable its personnel and researchers to be internationally aware, up-to-date, and responsive to emerging trends, new technologies and methodologies.
In a relatively short period of time, the Internet has become a powerful tool for both business and leisure pursuits. The Smart Internet Technology Cooperative Research Centre (CRC) is at the forefront of developments that will shape its future. It addresses two key technical issues: how to simplify and humanise the use of the Internet by developing natural and adaptive interfaces; and how to manage the complexity and growth of network services and devices.

The Centre’s multi-disciplinary research team at the University of Wollongong is comprised of technologists, communications experts and scientists. Their work focuses on three major projects. Smart Networks aims to develop a flexible network and server infrastructure to support future Internet services that are currently impractical or extremely costly. This work also involves the development of some of these applications. The Secure Multimedia Content Delivery project aims at designing secure Digital Rights Management systems for the delivery and consumption of multimedia content over the Internet. The Smart Learning Design Framework project is engaged in the development of a comprehensive multimedia framework for designing learning experiences.

Smart Internet is a joint venture between Australian industry, governments, and several universities to develop and commercialise world-class Internet technologies. It conducts research and development, licenses new technologies, and generates spin-off companies to market its discoveries.
CENTRE FOR ASIA PACIFIC SOCIAL TRANSFORMATION STUDIES

An Australian Research Council Key Centre for Teaching and Research, the Centre for Asia Pacific Social Transformation Studies (CAPSTRANS) is a joint venture of the University of Wollongong and the University of Newcastle. Its geographical focus — the Asia Pacific region — is a relatively new concept, established over the last two decades, and its boundaries are still being defined. Originally confined to countries in East and Southeast Asia and the islands of the Pacific, its scope has broadened to include members of the Asia-Pacific Economic Cooperation (APEC) group as well as the countries of the Indian subcontinent.

The Asia Pacific region includes some of the most populous countries in the world; some of the largest economies as well as the poorest; and some of the most remarkable examples of industrial transformation outside Europe and North America, such as Japan and Korea. It is, therefore, a region which offers unique insights into social transformation processes triggered by national and international development policies and their effects at local, regional and transnational levels. CAPSTRANS seeks to examine these processes through innovative research combining methods from a variety of disciplines, including political science, economics, sociology, anthropology, social history, education and media studies.

CAPSTRANS concentrates on six inter-linked research themes to achieve an understanding of social transformation in the Asia Pacific region:

> Colonial histories > International agencies and NGOs > Labour and mobility > Nation-states and regulatory regimes > Citizenship and identity > Community and sustainability.

THE ASIA PACIFIC REGION INCLUDES SOME OF THE MOST POPULOUS COUNTRIES IN THE WORLD; SOME OF THE LARGEST ECONOMIES AS WELL AS THE POOREST.
RESEARCH PROFILE 2005

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