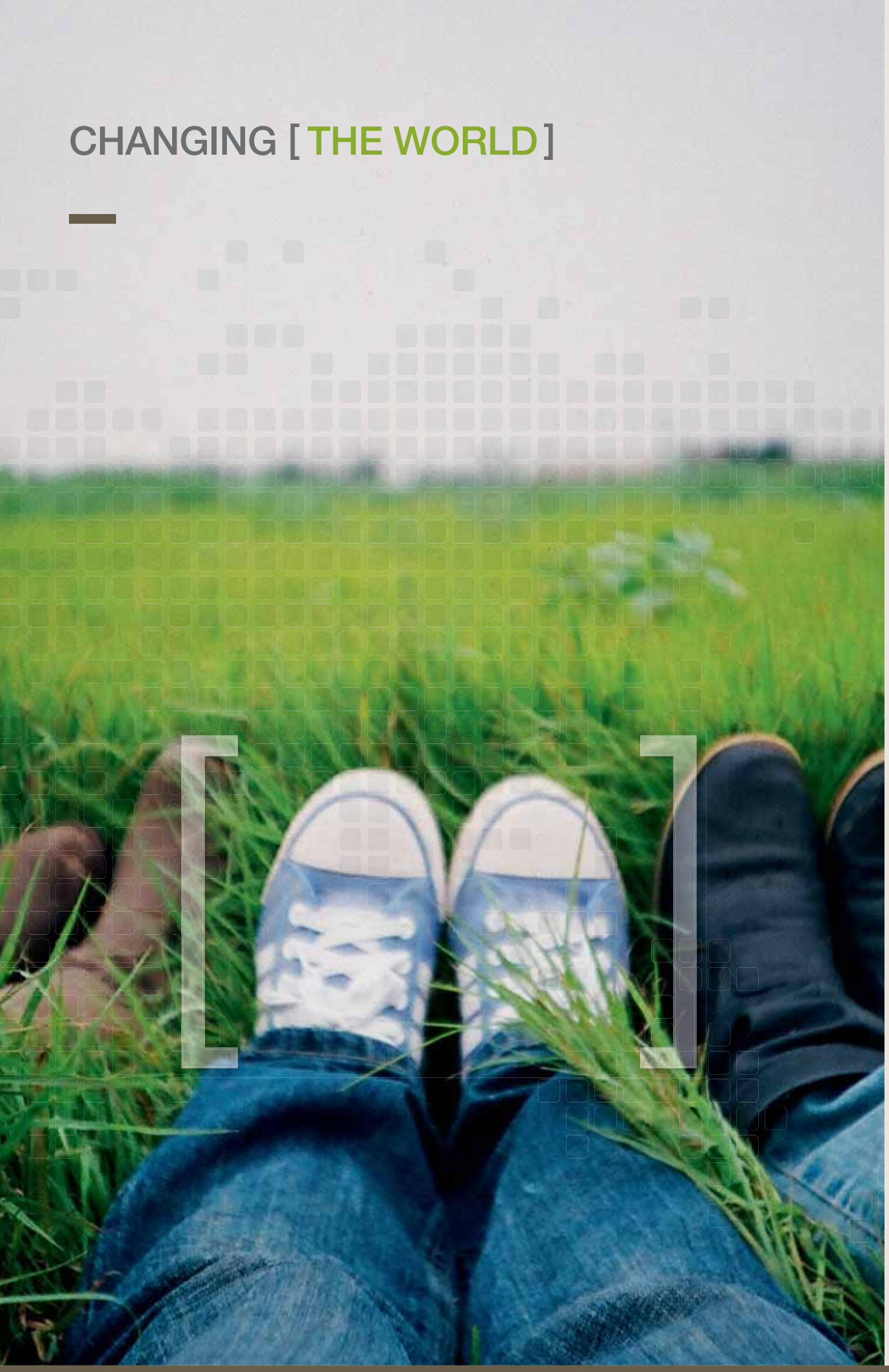
Research @UNSW

2010–2011

CHANGING [THE WORLD]

UNSW
THE UNIVERSITY OF NEW SOUTH WALES

CHANGING [THE WORLD]



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From leading the world in developing clean solar energy to finding the cause of one of Australia's longest droughts, UNSW research is finding answers to pressing environmental problems.

Solar power

Emissions trading

The crux of the drought

Coastal erosion

Making drinking water safe

Saving marine life

Waterbird warriors

CHAPTER ONE:

CHANGING [THE PLANET]

The solar story so far

For 35 years, UNSW has been a major force in photovoltaics research.

1975
- Solar Photovoltaic Group's first cell

1985
- World's first 20% efficient silicon solar cell*

1989
- World's first 20% silicon cell used for space* (confirmed by NASA on high-altitude aircraft)

1990
- 23% efficient silicon cell
- Swiss solar car "Spirit of Biel" wins World Solar Challenge using UNSW solar cell technology
- Martin Green wins international IEEE William R. Cherry Award for advancing photovoltaic energy technology

1991
- Group's first thin-film silicon cell
- BP Solar releases "Saturn" module under licence using UNSW technology (highest efficiency commercial module at 14.3%)

1992
- First large system using licensed UNSW technology built in Berne, Switzerland

1994
- 24% efficient silicon solar cell*

1995
- "Spin-off" Pacific Solar commences
- Buried contact cell most successfully commercialised in last 15 years

1998
- Pacific Solar announces pilot-line start-up (thin-film cells)
- BP Solar announces 20 megawatt, $57m plant in Sydney (buried contact cells)
- BP announced Amoco merger eventually leading to construction of this facility in Tres Cantos, Spain

1999
- Aurora 101 solar car wins World Solar Challenge with UNSW cells
- Australia Prize to Martin Green and Stuart Wenham for solar work

2000
- World's first undergraduate program in Photovoltaic Engineering starts*
- Third Generation Photovoltaics Centre commences

2002
- Centre of Excellence in Advanced Silicon PV and Photonics established
- Buried contact cell sales under license to UNSW exceed $300m

2006
- Collaboration with Suntech Power leads to announcement of commercial production of jointly developed technology for improved top contact design
- Stuart Wenham awarded World Technology Award for Energy
- Collaboration agreement signed with CEEG Solar, Nanjing, China

2008
- School wins IAG Eureka Prize for Innovative Solutions to Climate Change
- PhD student Nicole Kuepper wins British Council Eureka Prize for Young Leaders in Environmental Issues and Climate Change & People's Choice Eureka Award
- Martin Green honoured as New South Wales Scientist of the Year
- World record 25% conversion efficiency for silicon PERL cell

2009
- Stuart Wenham wins IEEE William R. Cherry Award
- Australian Solar Institute established
- Agreement with Roth & Rau to establish pilot production line at UNSW

* indicates world best

The solar solution

UNSW's world-leading solar cell research is proving that clean energy is a force to be reckoned with.

Solar electric power is the fastest-growing energy market in the world, with demand increasing at a rate of 40 percent or more annually for an energy source recognised as one of the most promising technologies for a clean, sustainable energy future.

UNSW is a world leader in solar cell technology, with a substantial portfolio of patented technologies, commercialisation agreements and international awards to its name (see timeline, page 6). Its research program is structured to address near, medium- and long-term needs.

Grid parity – matching the cost of fossil-fuelled electricity – remains the greatest challenge for photovoltaic power and the team at the University's ARC Photovoltaics Centre of Excellence is focused on pairing cutting-edge technology with market reality. Under the leadership of internationally recognised solar innovators, Scientia Professors Stuart Wenham and Martin Green, the Centre is a world leader in low-cost, first-generation silicon solar cell technology.

UNSW is a founding member of the Australian Solar Institute and will have unrivalled research capacity through the soon-to-be-constructed Solar Industrial Research Facility – the only industrial-grade silicon solar cell pilot line in the country. In 2012 UNSW will open its $125 million Tyree Energy Technologies Building, further enhancing the University's research capabilities.

In commercial terms, deals have been brokered for the team's breakthrough buried contact and semiconductor technologies with some of the world's largest solar cell manufacturers, including Chinese giant, Suntech Power, which was founded by UNSW alumnus Dr Zhengrong Shi.

The links between UNSW and Suntech are having an impact at the heart of Sydney's emerging harbourside arts precinct. An agreement has been made to install Australia's largest-capacity rooftop solar panel array at the Sydney Theatre Company's (STC) historic Walsh Bay building.

The array, to be installed this year, will comprise 2000 high-efficiency Pluto solar photovoltaic panels and will supply up to 70 percent of the STC's power requirements, cutting its carbon emissions by about 555 tonnes a year – the equivalent of taking 158 cars off the road.

Dr Shi and his wife, Vivienne, made an extraordinary $2 million donation from their family charitable foundation to create the solar array, which will be part of the STC's broader Greening the Wharf sustainability project.

The Pluto cell used in the panels is a low-cost implementation of UNSW's world-record-holding 25 percent efficiency PERL solar cell technology. Jointly developed by Suntech and UNSW's School of Photovoltaic and Renewable Energy Engineering, the technology's use at the STC is its first major installation in Australia.

THE OPPORTUNITY

PhD and post-doctoral research opportunities are available, as are industry and government partnerships.

Photo Grant Turner, Mediakoo

The power to change ... Scientia Professors Martin Green (left) and Stuart Wenham

Photo Kate Geraghty, Fairfaxphotos.com

Bright future ... Nicole Kuepper develops cheap solar cells in the lab

Alternative approaches

Innovation is the key to powering the future.

UNSW Photovoltaics PhD student Nicole Kuepper captured the collective imagination when she took out the 2008 People's Choice Eureka Award for her work developing a cheap way to make solar cells in developing countries.

Cheap solar cells created using simple components – aluminium spray, inkjet printing, nail polish remover and low-temperature pizza ovens – could deliver clean energy to thousands of poor communities with no access to grid power. It's research that demonstrates how inspired engineering could deliver rapid results in the real world.

Current solar cell production methods are expensive and require high-tech equipment, putting them out of reach for most people in poorer nations.

"We're working to simplify how the cells are manufactured so they can be produced in developing countries," Kuepper says.

"We're up to the really exciting stage of creating prototypes."

Kuepper, who is studying at UNSW's School of Photovoltaic and Renewable Energy Engineering is passionate about the potential of solar power.

"I want to stay in this field and see it become a world energy resource," she says.

Dr Evatt Hawkes, also of the School of Photovoltaic and Renewable Energy Engineering, is looking at developing more-sustainable fuels and engines for transport.

With more than 90 percent of the world's transport reliant on combustion engines, researchers are looking to find ways to drastically reduce fuel consumption, pollution and greenhouse gas emissions.

Dr Hawkes has developed computational tools which are leading to a better understanding of the fundamental physics and chemistry behind combustion. This aids the development of new, sustainable fuels and engine designs.

"In a low carbon energy environment and with increasing dependence on imported oil, you have really got to think about what you are going to do in transportation fuels," he says.

"I think there is some opportunity to electrify urban vehicles but there are some areas where electrification just can't work, such as aircraft and heavy trucking. It's in these areas that liquid fuels will remain vital."

Dr Hawkes is researching how to optimise ethanol as a future fuel.

"Alternative fuels are going to be a huge growth area. Biofuels hold much promise but we need to reduce the cost, environmental impact and the competition with food. We really need to work this problem from all angles – that includes more productive crops, better ways of converting the crop into fuel and better ways of burning the fuel in engines," he says.

THE OPPORTUNITY

PhD and post-doctoral research opportunities are available, as are industry and government partnerships.

Photo Shutterstock

Polluter pays ... coal-fired power plants would be part of any emissions trading scheme

Cleaning up

UNSW researchers are testing the proposed carbon trading scheme, to make sure it comes up to scratch.

The idea behind emissions trading schemes is simple enough; if it costs to pollute, then cleaner energy and greener industries, transport and lifestyles should flourish.

But such environmental levers are "designer markets"; their effectiveness, or otherwise, depends entirely on a complex set of rules, policies and regulations.

Environmental economist, Dr Regina Betz, from UNSW's Australian School of Business (ASB) is at the forefront of research on design models for emissions trading schemes. This research has potential to inform policy formulation and implementation of schemes currently under consideration by sovereign governments. For example, the Australian Federal Government plans to issue about 400 million carbon permits – or tradable "permits to pollute" – in the first year of the scheme. Around 75 per cent of these would be auctioned. Other governments are to consider similar schemes. The penalty of not having enough permits is set at a fixed price in the first years and will be linked to the auction price later on.

Together with her PhD student Phillia Restiani, Dr Betz has conducted "mock" auctions and market simulations in a new Experimental Research Laboratory.

Using environmental and experimental economics, market design, statistics and econometrics, they are investigating the impact of the penalty design and permit allocation procedures on performance of the market. They'll also gain some insight into human decision making; why one business might choose to pay to continue polluting, while another will invest early in reducing its carbon footprint.

"These are purely designer markets, so we need to understand how to achieve emissions reductions efficiently and at the lowest cost," says Dr Betz.

The ASB team also used "prediction markets" to forecast possible outcomes of the crucial Copenhagen Climate Change Conference; a tool which may prove useful in other negotiation settings.

At the same time, ASB researchers are also working on the development of global carbon assurance standards for the new, green bottom line.

With more than 40 reporting schemes worldwide and various assurance requirements, there's great uncertainty, says Professor Roger Simnett, head of the ASB's School of Accounting.

"International reporting and assurance standards are essential to establish confidence in carbon trading systems and the 'carbon prices' they generate as well as ensuring schemes achieve their environmental aims," he says.

Professor Simnett – who is working with ASB's Dr Wendy Green, CPA Australia and The Institute of Chartered Accountants in Australia – is co-chair of the International Auditing and Assurance Standards Board (IAASB) task force that is developing a global assurance standard.

On the other side of the equation, environmental problems are also offering economic opportunities.

UNSW's low emissions building products made from the fly ash by-product of coal-fired power stations, for example, clean up a serious pollutant while reducing the carbon footprint of the construction industry – saving money for businesses required to hold permits under carbon trading schemes.

THE OPPORTUNITY

Postgraduate research opportunities and collaborations exist across a range of initiatives.

The heat is on

As the climate change debate warms up, UNSW research is unravelling the complex interplay between emissions from the land, sea and air.

Photo Brad Morris

Rising concentrations of greenhouse gases are the focus of much global attention in efforts to come to grips with climate change and its effect on our lives and environment. But often neglected in the discussions is the impact on the world's oceans.

Shedding some new light on the problem is UNSW's Climate Change Research Centre (CCRC). Led by joint directors Professor Matthew England and Professor Andy Pitman, the CCRC is playing an increasingly influential role internationally. It was recently involved in a global liaison project between elite climate researchers in the lead-up to the UN climate change talks in Copenhagen, updating the science that underpinned the 2007 consensus report of the UN Intergovernmental Panel on Climate Change.

Researchers at the CCRC also recently revealed that the causes of south-eastern Australia's longest, most severe and damaging droughts originate far away in the Indian Ocean.

Working with other researchers, the team detailed for the first time how a phenomenon known as the Indian Ocean Dipole – a variable and irregular cycle of warming and cooling of ocean water – dictates whether moisture-bearing winds are carried across the southern half of Australia.

The landmark study explained the record-breaking drought in south-eastern Australia and solved the mystery of why a string of La Niña events in the Pacific Ocean – which usually bring rain – has failed to break it. To make matters worse, this period has coincided with a trend towards higher average air temperatures over the land, which may be linked to human-induced climate change.

In another recent study, the CCRC's Dr Ben McNeil and colleagues found climate change is taking its toll on our marine life. Of the 30 billion tonnes of carbon dioxide emitted into the atmosphere through fossil-fuel burning, about one-third is absorbed by the ocean. There, it not only reduces seawater pH but also reduces carbonate mineral saturation, which plays an important role in calcification for many marine organisms and thus for the marine food chain.

Their study predicts the Southern Ocean will acidify much earlier than previously thought, causing the shells of sea creatures to dissolve. That point will be reached when atmospheric carbon dioxide levels pass 450 parts per million, which is predicted to occur within 30 years at most.

"Ocean acidification is a direct consequence of increasing atmospheric carbon dioxide concentrations," notes Dr McNeil.

When climate change experts talk about a "tipping point" they are usually referring to an atmospheric point of no return; that moment when emissions-driven global warming irreversibly alters life on Earth.

But, there's another related "tipping point" at which life may change forever.

Rider on the storm ... Dr Mitchell Harley from the Water Research Lab surveys coastal erosion

For nations like Australia, with its people and infrastructure concentrated along the coastal fringe, the rising sea levels and extreme weather events of climate change pose some vital questions. Is there a point at which the coastline will begin to erode and change dramatically on a scale never seen before? If so, what do planners and policy makers need to know to make informed decisions about when to reinforce coastal communities or when to retreat inland?

Several projects, led by Associate Professor Ian Turner of UNSW's Water Research Laboratory (WRL), are contributing to the urgent need for forecasting on vulnerable stretches of coastline. A recent federal parliamentary committee identified up to $150 billion worth of Australian coastal property currently at risk.

Working internationally and locally, UNSW researchers are investigating an apparent, but little understood, mathematical equilibrium, which seems to have long kept coastlines largely intact – bringing sand back on to beaches eroded by big seas.

Whether rising sea levels and more frequent storms – like those which dramatically shifted Sydney's sands in 2009 – will disrupt this equilibrium is crucial to the future shape of our shoreline boundaries.

At the same time, a collaboration with the NSW Government and the surfing community is deploying networks of cameras, usually used by surfers to check out waves online, for long-term monitoring of changes to hundreds of Australian beaches.

A third major program focuses on forecasting out to 2100, using all possible inputs to calculate risk.

"The best evidence suggests sea levels are rising in the upper range of what was predicted; we need to know how fast and how much coastlines are going to change," says Professor Turner.

WRL's Associate Professor Ron Cox has recently completed a pilot study in Tasmania assessing "adaptation" options for one coastal community as sea levels rise, ranging from abandoning the town to building huge sea defences. The study is part of a major new WRL research project into optimum climate change adaptation strategies for coastal Australia.

Professor Cox also leads the new federally funded Australian Climate Change Adaptation Research Network for Settlements and Infrastructure.

THE OPPORTUNITY

A comprehensive range of postgraduate opportunities exist across these fields of research.

Flow of ideas

The world's most abundant resource is being carefully scrutinised to ensure not a drop is wasted.

Photo Patrick Cummins

Fifty years ago, when UNSW's Water Research Laboratory (WRL) opened its doors, water experts were thinking about two main issues: huge dams to insure against drought, and hydroelectric and thermal power stations to provide energy. Virtually everything Australians then knew about water was based on overseas research.

Today, water research encompasses issues ranging from environmental protection of wetlands, climate change, drought cycles and alternative water sources. But underpinning these research efforts is the essential understanding of Australia's unique hydrology built up at the WRL over half a century. Some 4,000 technical and research reports and 2,000 major industrial projects have been completed since the laboratory opened.

Research at the WRL, led by director Dr Bill Peirson, also now has a global perspective. For example Dr Peirson and his team are advancing our understanding of dangerous sea conditions and coastal inundation, including the formation of "rogue waves" which can sweep rock fishermen into the ocean, even when the sea appears calm.

Beyond coastal safety, the sea surface also holds the answers to the urgent global questions of how energy, heat and gas are exchanged between the atmosphere and the oceans.

"Determining the rate at which the oceans are absorbing carbon dioxide is important for climate change predictions, because it directly affects the severity of what is happening in the atmosphere," Dr Peirson says.

His team is collaborating with US investigators in studying how waves, from the tiniest ripples to the ocean giants, disrupt the sea surface and how that disruption affects the exchange of CO_2 and the heat that drives tropical storms.

Inland, where drought is challenging farming practices, UNSW researchers led by Professor Ian Acworth have developed a 3D-imaging method to track the movement of water as it soaks into the ground.

Using electrical tomography, the method detects over-watering by measuring whether water is running off into the subterranean aquifers way below the root zone; offering irrigators an opportunity to use less of a dwindling resource.

This breakthrough launched the Connected Waters Initiative (CWI); a quantitative analysis of ground and surface waters to enable sustainable management of major irrigation areas.

The future of Australia's vital wetlands, as feeder rivers decline, is also under scrutiny.

Professor Richard Kingsford, at the School of Biological, Earth and Environmental Sciences, has played a major role in investigating the nation's ailing river systems and the devastation wrought on bird life and other native species.

Now Professor Kingsford is leading the largest-yet survey of the country's vital wetlands conducting aerial studies across the continent to track the abundance and diversity of waterbirds to determine the ecosystem's health.

"Wetlands with large numbers of waterbirds are in a healthy condition," he says. Australians need no reminding that fresh water is not only a finite resource, but is in increasing demand as the nation's population grows. So there's an increasing focus on ensuring water supplies from dams and rivers are free from contamination and on recycling wastewater for re-use.

In the deep ... Professor Brett Neilan's work has been used by the World Health Organization

In dams and rivers, different strains and species of blue-green algae or bacteria may be potentially deadly with drastic implications for water supply.

A team led by Federation Fellow Professor Brett Neilan in the School of Biotechnology and Biomolecular Sciences, is trailblazing sophisticated new ways to determine which bacteria or algae are harmful.

The research group at UNSW is considered to be one of the world leaders in the genetics of cyanobacteria, or blue-green algae. Proving the point, in 2009 Neilan won a record third Eureka prize for his work in the area, plus a NSW Scientist of the Year award.

Professor Neilan helped uncover all four biochemical pathways responsible for the production of potent bacterial and algal toxins that contaminate our water supplies and accumulate in seafood.

In a measure of the significance and impact of his research, many international groups, including the World Health Organization, have already adopted Neilan's techniques for the rapid and accurate detection of blue-green algae in drinking water supplies, and these patented tests are now the standard means of assessing environmental health.

"The research had its origins in the early 1990s and problems in Queensland, New South Wales and South Australia with massive proliferations of blue-green algae," says Professor Neilan.

NewSouth Innovations has licensed Neilan's technology to a company that will produce a diagnostic kit pinpointing the genes that cause potent toxins in blue-green algae and provide an early-warning testing system that differentiates harmful and non-harmful species.

Further down the water chain, UNSW researchers are taking an innovative approach to ensuring water treatment systems are working.

A team at the UNSW Water Research Centre, including Dr Stuart Khan, Dr Rita Henderson and Professor Richard Stuetz, is developing new water monitoring tools that use fluorescence spectroscopy to provide immediate analysis of the effectiveness of water treatments such as reverse osmosis and disinfection.

"High-grade recycled water is used in industrial applications and in household dual reticulation systems but there are potential risks associated with under-performance or failure of treatment processes," Dr Khan says.

Existing water monitoring systems may not pick up incidents of treatment failure quickly enough, but fluorescence spectroscopy has proven effective as a highly sensitive, easily utilised and high-speed method of testing for dissolved organic compounds.

By detecting the chemicals coming through the treatment system the new method gives a fast, clear indication of how effective the treatment has been.

THE OPPORTUNITY

PhD and post-doctoral research opportunities are available, as well as industry and government partnerships.

From new approaches to tackling cancer, to restoring sight among the vision impaired, UNSW research will benefit countless lives.

Fighting HIV/AIDS

Schizophrenia and bipolar disorder

Developing a smart drug

Changing cancer treatment

Restoring sight

Bionic eye

Surgery without stitches

No-wait blood tests

Stopping scars

CHAPTER TWO:

CHANGING [HEALTHCARE]

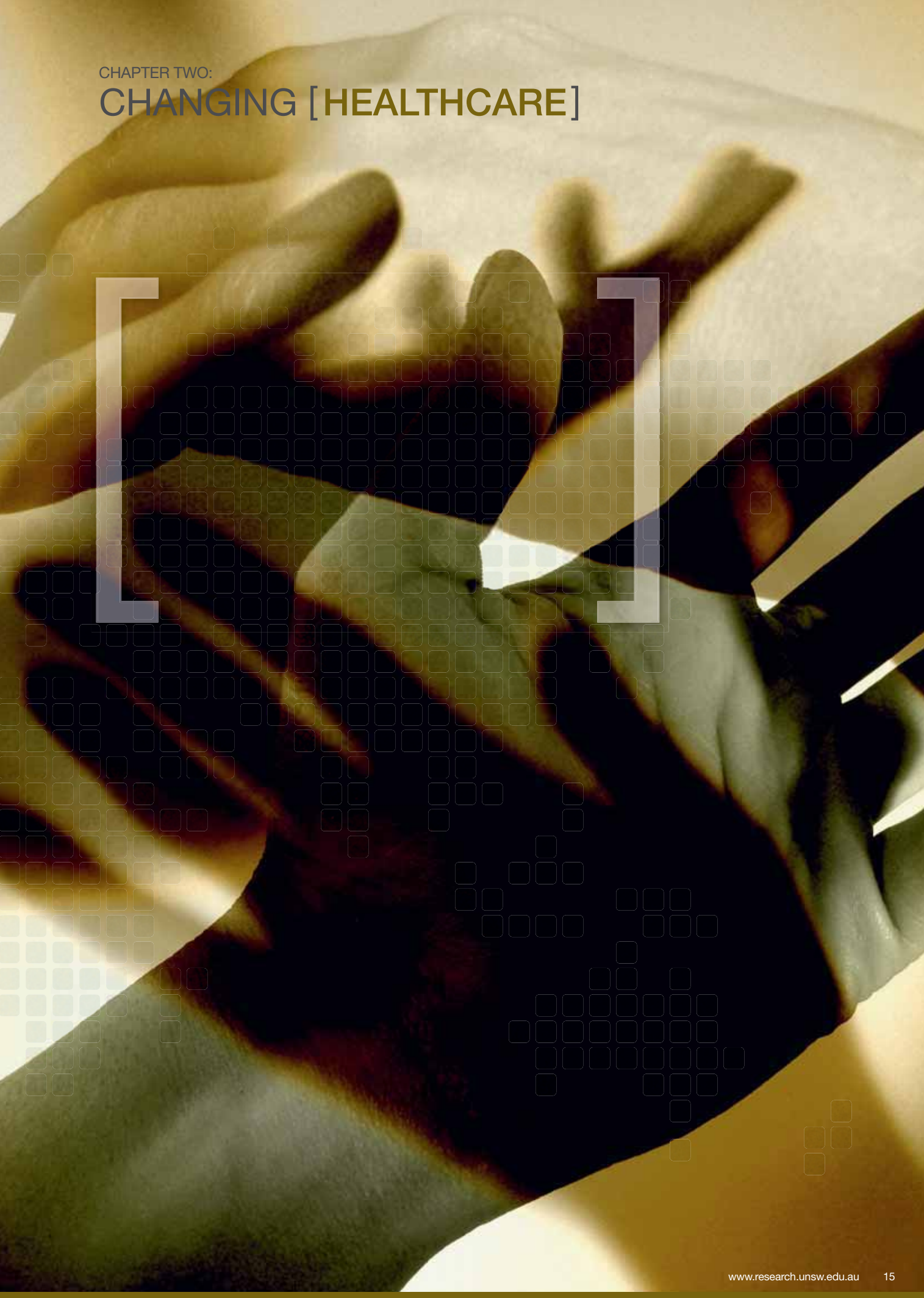


Photo Nic Bothma, Corbis

Left alone ... a South African child at an orphanage which cares for many children who have lost their parents to HIV/AIDS

Building strength

HIV-infected people in developing countries stand to benefit from groundbreaking work at UNSW.

With more than 30 million people infected with HIV and no vaccine or cure in sight, global efforts to combat the epidemic are focusing on antiretroviral therapies that can keep patients alive and reduce the risk of new infections.

By 2015 nine million people in developing countries will have access to the expensive drugs, up from three million currently.

The success of the rollout is putting enormous pressure on the ability to manufacture and pay for the drugs.

But what if the existing drugs could be made to go further? Could dosing levels be tweaked without compromising the drugs' effectiveness? If so, millions more of the world's HIV-affected people could be treated for little or no extra cost.

A UNSW team led by Professors David Cooper and Sean Emery, at the National Centre in HIV Epidemiology and Clinical Research (NCHECR), has begun trials to see if the daily dose of one antiretroviral drug – efavirenz – can be reduced to 400 mg from the current 600 mg without compromising effectiveness.

Funded by a grant of more than $18 million from the Bill & Melinda Gates Foundation, the two-year, 700-patient trial is dubbed ENCORE (Evaluation of Novel Concepts in Optimisation of Antiretroviral Efficacy). It will be carried out by a research network in Australia, the Americas, Europe and Asia, with results to be published by mid-2013.

"Our goal is to ensure that everyone who needs treatment for HIV is able to access it," Professor Cooper says. "And if that can be done for less cost, then that's a great result."

The Gates' donation is the latest in a string of funding successes for NCHECR, reflecting the international standing of the Centre led by Professor Cooper, a world-renowned HIV clinician and clinical investigator.

A past president of the International AIDS Society, Professor Cooper is leading the push to transform NCHECR into a national institute for infectious diseases.

Supported by $40 million from the NSW and Federal governments, the new institute will bring together 300 of the nation's top scientists investigating viral hepatitis, HIV/AIDS and other sexually transmitted infections (STIs).

NCHECR has also won a $9.1 million NHMRC grant for a program to control STIs among young people, Indigenous Australians and gay men, and $17.7 million for a vaccine development program for HIV and hepatitis C, led by Professor Cooper.

The groundbreaking initiative's eight other chief investigators include colleagues from Royal Perth Hospital and the universities of Adelaide and Melbourne, Andrew Lloyd (UNSW's School of Medical Sciences) and three NCHECR program heads, Professors Emery, Tony Kelleher and Greg Dore.

Professor Dore's research has found that up to 70 percent of hepatitis C patients could be cured – and many serious liver conditions prevented – if patients sought early treatment with standard combination drug therapy.

THE OPPORTUNITY

Research opportunities exist in mathematical modelling, vaccine work and Indigenous health.

Photo Patrick Cummins

Finding the links ... Dr Melissa Green with Scientia Professor Philip Mitchell

Unlocking secrets of the mind

New research suggests many similarities between schizophrenia and bipolar disorder.

Evidence suggests schizophrenia and bipolar disorder can be inherited, but how do you identify those most at risk? What are the subtle first signs of onset? And who will show resilience?

To help find answers researchers from Brain Sciences UNSW are driving two landmark international studies to pinpoint risk factors and provide the information for early identification and treatment.

"There is still no way of identifying someone in the very early stages of bipolar or schizophrenia, or someone who is most at risk," says Scientia Professor Philip Mitchell, the head of the School of Psychiatry and one of the country's leading brain science experts.

"Current identification practices are extremely poor. It's like only diagnosing people with heart disease when they present with a heart attack," he says.

To fill the gap, Dr Melissa Green, an ARC Future Fellow, has brought together sufferers of schizophrenia and bipolar disorder to determine similarities and distinctions between these diseases' genetic causes and manifestations.

Dr Green and her team will integrate data from genetics, functional neuroimaging, cognitive testing and physiological measurements to identify shared genetic susceptibility, which may manifest in common cognitive and frontal brain dysfunctions.

Results from the study, being conducted in collaboration with the Schizophrenia Research Institute, the Black Dog Institute, the Prince of Wales Medical Research Institute and Leiden University in The Netherlands, are already indicating that schizophrenia and bipolar disorder are more similar than previously thought.

"Already some medications are commonly prescribed for the two disorders, to treat overt psychotic symptoms. With more information, new drugs could be developed to improve the enduring cognitive deficits as well," she says.

A second landmark study to identify those most at risk from bipolar disorder is being led by Professor Mitchell and the Black Dog Institute. The study – the largest of its type, with partners in four US-based research institutions – will recruit 500 young Australians who have at least one relative with the illness.

Also boosting schizophrenia research is the appointment of Professor Vaughan Carr to Australia's first Chair in Schizophrenia Epidemiology and Population Health. The Chair is a joint project with the Schizophrenia Research Institute, with funding of $2.125 million from NSW Health.

Professor Carr is comparing records from health and education departments to uncover new risk factors. Potential relationships between pregnancy complications, school performance and behavioural problems could point to later development of schizophrenia or other mental health problems.

The appointment cements UNSW's reputation as a world leader in the field and complements the work of Cyndi Shannon Weickert as Macquarie Bank Group Chair of Schizophrenia Research.

THE OPPORTUNITY

A PhD Scholarship in imaging genetics is available, as are PhD opportunities in bipolar research.

Photo Patrick Cummins

A broad scope ... Professor Levon Khachigian has invented a drug with many applications

Stalking a killer

The secrets of Australia's biggest killer – cardiovascular disease – are being pieced together by UNSW researchers.

Imagine the possibility for disease prevention if we could develop a smart drug to act like a friendly assassin in the body, neutralising the master regulator genes that play a role in some of our most common diseases.

A smart drug which does just that – Dz13 – is ready to be trialled on humans.

Developed by Professor Levon Khachigian, an Australia Fellow and Director of the UNSW Centre for Vascular Research, the breakthrough has global implications for the treatment of diseases ranging from age-related macular degeneration, diabetes-induced blindness, arthritis, certain cancers and even cardiovascular disease.

Starting this year Khachigian will use Dz13 to "switch off" a master disease-regulating gene in skin cancer patients. Once it's found to be safe and well tolerated, human trials will begin for other conditions.

"The drug is like a 'nano-assassin' that gets into cells under the cover of darkness, then seeks out and destroys its molecular target," says Khachigian.

Pre-clinical studies have already shown Dz13 can dramatically reduce heart muscle damage after a heart attack and may lead to significantly improved patient outcomes.

The drug also reduces incidental cell and tissue death in procedures such as balloon angioplasty and stent placements, and may have a role in improving the effectiveness of coronary artery bypass grafts.

Significantly, the heart's pumping action is protected by the drug, improving the patient's chances of a full recovery.

"While this drug doesn't prevent the heart attack, it does reduce the damaging effects of the blockage on the heart once it's happened," Khachigian says.

Until recently, the human heart was thought to have little or no ability to repair itself by regenerating new tissue.

Recent studies from UNSW Professor Bob Graham's laboratory (in collaboration with colleagues in the US) have shown that even mature heart muscle cells can be coaxed into dividing and thus, regenerating heart tissue.

"That the heart has any regenerative capacity at all is an enormous surprise, and that even mature heart muscle cells can divide flies in the face of dogma that has been around for many, many years," says Professor Graham, who is based at the Victor Chang Cardiac Research Institute.

Graham's work gives much hope to the many thousands of people worldwide who suffer a heart attack.

THE OPPORTUNITY

Research and PhD opportunities are available in the Centre for Vascular Research while the Victor Chang Cardiac Research Institute offers research, PhD, BSc (Hons) MSc and post-doctoral opportunities.

Photo Patrick Cummins

Putting people first ... Professors Robyn Ward and Philip Hogg

Conquering cancer

New treatments developed at the Lowy Cancer Research Centre are revolutionising the fight against the disease.

Cancer breakthroughs make headlines, but if they don't lead to new treatments and cures they're little consolation to the more than 110,000 Australians diagnosed each year with the disease.

Ensuring discoveries in the lab make a difference at the bedside is the aim of UNSW's newly built $100 million-plus Lowy Cancer Research Centre and its inaugural director Professor Philip Hogg.

Professor Hogg is overseeing the relocation of more than 400 medical scientists from the Faculty of Medicine and the Children's Cancer Institute Australia (CCIA) to the facility, which brings together adult and childhood cancer research for the first time.

Combining the two makes the Centre somewhat unique, Professor Hogg says, but it's the focus on getting oncology breakthroughs to the people who need them – the patients – that really sets it apart.

"Good translational research – that's what we are probably better at than almost anyone else," says Professor Hogg, who was named 2009 NSW Cancer Researcher of the Year.

Professor Hogg's colleague, Professor Robyn Ward – winner of the same prize in 2007 – is charged with getting Lowy's basic science into the clinic.

Diagnostic tests for childhood leukaemia, developed by CCIA, are already in use, while Professor Ward's own research into the interplay between genetic and epigenetic codes has identified an additional mechanism by which people inherit cancer predisposition – essential information if screening is to be targeted and cost-effective.

In 2010, Professor Ward will also guide landmark human trials of a second-generation cancer-fighting drug developed by Professor Hogg. The trial, funded by the Cancer Institute of NSW, will be conducted at the Prince of Wales Hospital.

The drug's precursor is already showing promising results in treating ovarian cancer in trials in the UK. The anti-mitochondrial compound "starves" tumours to death by cutting off their blood supply. While those trials could find funding only overseas, Professor Hogg credits the Lowy Centre with bringing the second phase home.

"The new drug to be trialled in Australia is about 20 times more effective than the original and in animal trials at least, it's also better tolerated," says Professor Hogg. If the results are replicated in humans, the world could have a new class of therapy consisting of the two new drugs targeting a number of cancers.

"It will be very exciting to take a drug developed at UNSW, and put it into human trials at the only site in the state that has an FDA-approved phase-one facility," Professor Ward says. "That's an important part about Lowy. It's located next to the big hospitals and you can take the discovery from Lowy and test it next door."

Professor Hogg agrees: "You can count on one hand the number of home-grown drugs that have actually made it into the clinic. To have two of them – well, that's unique. It's real translational medicine."

THE OPPORTUNITY

Postgraduate research opportunities are available in the causes of cancer and application of new drug treatments. This encompasses basic research into epigenetic changes that underpin the development of colorectal cancer and brain tumours.

Photo Grant Turner, Mediakoo

Seeing the light ... Doctors Stephanie Watson and Nick Di Girolamo

Eye on the prize

In a world-first breakthrough, stem cells cultured on a simple contact lens are restoring sight to sufferers of blinding corneal disease.

Contact lenses have transformed vision for millions of people, but now the technology is being used to restore the sight of sufferers of blinding corneal disease.

Dr Nick Di Girolamo and Dr Stephanie Watson, from UNSW's Centre for Infection and Inflammation Research, have developed a non-invasive technique that uses contact lenses to deliver stem cells to the cornea.

Stem cells are harvested from a patient's own eye, cultured on a simple contact lens and placed on to the cornea, allowing the stem cells to "re-colonise" the damaged eye surface.

The novel technique is a significant breakthrough for a range of painful and debilitating conditions, which have been notoriously difficult to treat.

Doctors Di Girolamo and Watson have trialled the technique on two patients with corneal damage and one suffering from a genetic eye condition. In all three patients, sight was significantly improved within weeks.

The simplicity of the procedure means it is ideal for developing countries without access to sophisticated medical facilities.

Stem cells have also been used by UNSW researchers to re-grow muscles in mice. The discovery last year opened up a world of possibilities in treating human diseases by regenerating whole tissues.

While Professor Peter Gunning, Professor Edna Hardeman and Dr Antonio Lee are focusing on muscles, and muscle-wasting diseases such as myopathy and muscular dystrophy, their breakthrough technique has potential applications for all tissue-based illnesses, affecting areas such as the brain, liver and pancreas.

The researchers from UNSW's School of Medical Science managed to dramatically strengthen the ability of donor muscle stem cells to regenerate damaged tissue by adapting a technique being trialled in bone marrow transplantation. A gene is introduced into the donor stem cells making them resistant to chemotherapy, which is then used to clean out the damaged cells and allow the new stem cells to take hold.

"Until now the new, healthy cells had no advantage over existing damaged cells and were getting out-competed," says Professor Gunning.

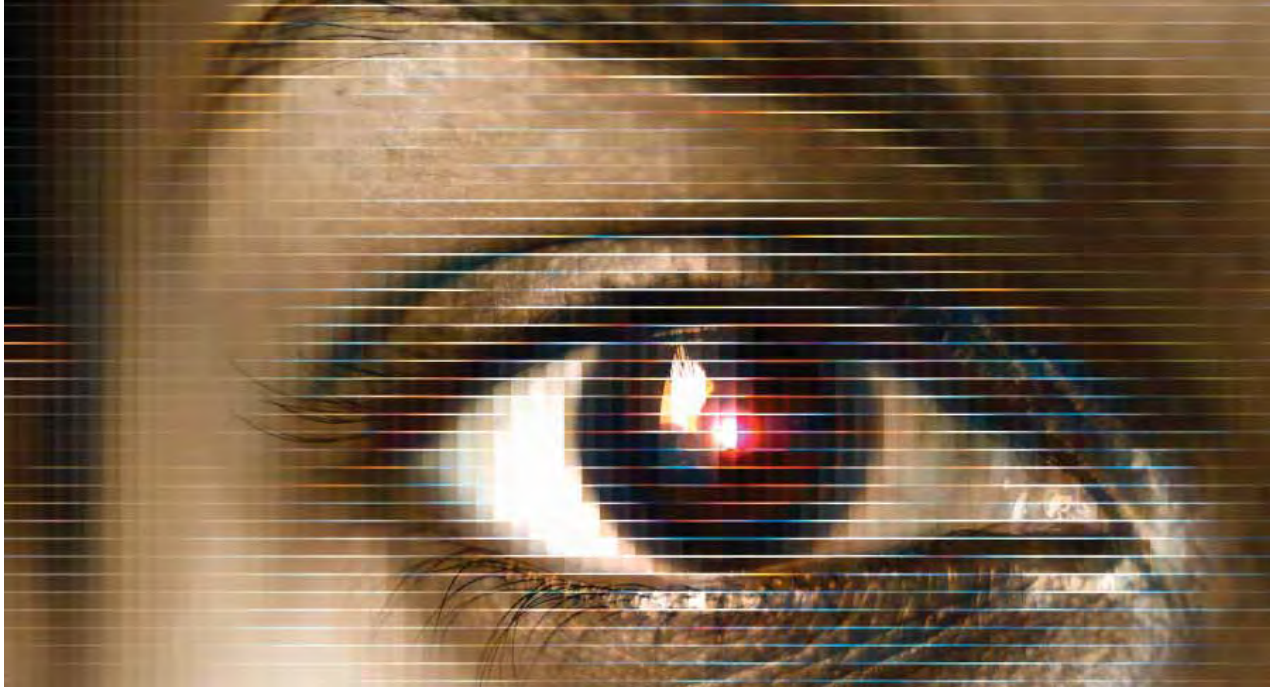
He says the research, backed by the Oncology Children's Foundation, has also recently turned up another positive result; that muscle stems cells do not lose their ability to regenerate as they age, meaning a parent or grandparent could be a suitable donor for a sick child.

While human trials are at least three to five years away the results move regenerative treatment into the realm of real-world possibility.

THE OPPORTUNITY

PhD and post-doctoral research opportunities are available.

Illustration Mehau Kulyk, Science, Corbis



A great leap forward ... creating a bionic eye to help the vision impaired

Future vision

Research is about to deliver a bionic eye, one of several breakthroughs set to improve the lives of the vision impaired.

A grand vision is nearing completion. Professor Nigel Lovell and Associate Professor Gregg Suaning have developed a viable vision prosthesis, and a UNSW-prototype "eye" could be ready for human implantation as early as 2012.

The researchers from the Australian Vision Prosthesis Group are developing a 98-channel device that has the potential to create relatively detailed, patterned vision using signals fed through the retina, at the back of the eye.

UNSW's "bionic eye" team is a lead member of the Bionic Vision Australia (BVA) consortium that brings together Australia's best biomedical engineering, clinical and surgical researchers.

The strength of the BVA consortium, plus the Federal Government's recent $50 million commitment to fund relevant research, offers Australia the best possible chance of building a world-leading bionic eye, to follow the world-first Australian "bionic ear", or cochlear implant, according to Associate Professor Suaning.

While other researchers worldwide are pursuing the same goal, the UNSW project has two unique characteristics; the use of existing, safe materials to achieve greatly enhanced bio-compatibility, or human tolerance, of a "bionic eye", and new ways to introduce multiple electrodes into the retina.

This will allow an external micro-camera and micro-processor mounted on glasses to transmit a signal to an electronic circuit and electrode array connected to the retina – offering realistic hope to sufferers of common eye conditions such as macular degeneration and retinitis pigmentosa.

The vision impaired can also expect to benefit from emerging navigational technologies.

Researchers from UNSW's School of Surveying and Spatial Information and the School of Computer Science and Engineering are combining the best available positioning systems – such as Assisted GPS, WiFi, Radio Frequency Identification and Inertial Navigation System – to generate an unprecedented "picture" to assist the vision impaired to navigate through daily life.

The aim is to produce a low-cost, off-the-shelf unit, similar to an iPhone, enabling the user to move seamlessly from GPS outside, for example, to other technologies inside to detect the locations of doors, stairways and other features.

The greatest challenge is creating the software to achieve the smooth integration of different navigational technologies, says spatial systems engineer, Dr Binghao Li.

"We don't expect to entirely replace a cane, but we aim to provide the vision impaired with a great deal of rich, new navigational information," says Associate Professor Andrew Dempster, who leads UNSW's research into new navigation technologies.

Both projects illustrate the range of applications of new technologies and highlight UNSW's research strengths. UNSW hosts both Australia's largest biomedical engineering school and Australia's largest group investigating satellite navigation and location technologies.

THE OPPORTUNITY

PhD and post-doctoral opportunities are expanding in the growing bionic eye research team. In location technologies, several PhD scholarships are on offer.

Hi-tech health

Surgery without stitches and no-wait blood tests are transforming our most common medical procedures.

Photo Mike Gal

The days of waiting – sometimes nervously – for the results of a blood test are numbered.

Professor Justin Gooding, from UNSW's School of Chemistry, has developed hand-held devices that will make blood tests faster and more efficient. This will ensure effective follow-up can be arranged without delay.

The kits can even be used by non-specialist staff with huge savings – estimated at up to 20 percent – for the health budget.

The technology – which won Professor Gooding the 2009 UNSW Eureka Prize for Scientific Research – also includes sensors that minimise side effects from drugs and assist with pesticide detection in drinking water.

"Ultimately the research will enable the development of diagnostic devices to detect bioactive compounds, and predict how people will respond to them," says Professor Gooding. "This means customising dosage and types of drugs for individual patients, minimising side effects, and again saving costs."

Other revolutionary technology developed at UNSW is already in use in about a third of Australian pathology labs. The system – known as Ripple-Down Rules (RDR) – has dramatically simplified the way knowledge-based systems are managed.

Professor Paul Compton, the head of the School of Computer Science and Engineering, devised the approach as a way of building and changing computer systems while they are already in use.

"RDR doesn't specify a particular technology," he says. "Rather it's the basic idea that you can very simply add a rule to a system without corrupting the existing knowledge in the system."

Professor Compton is a founder of spin-off company, Pacific Knowledge Systems, which provides the technology for pathology. At least five other companies worldwide have technology based on RDR.

A 2010 ARC Discovery Grant will look at RDR systems that can anticipate when a system cannot deal with a problem.

Also utilising technology for healthcare is Associate Professor Pradeep Ray and a team from the Asia–Pacific Ubiquitous Healthcare Research Centre.

They have been looking at electronic health (e-health) systems in developing countries and the use of mobile phones to optimise healthcare in emergencies, such as natural disasters.

Professor Ray says health professionals on the ground could text doctors outside the area to seek advice.

"Often phone lines are congested in a disaster," explains Professor Ray. "Texting would allow for some response. While it would not be a full diagnosis, it would allow vital information to be passed on."

If the phone infrastructure is destroyed, satellite phones could be used.

Trials in Indonesia after the 2004 tsunami proved so successful the World Health Organization has sponsored the next stage of the study – assessing e-health in India, China, Vietnam and the Philippines.

Some surgical practices have changed little over time. Ancient Egyptian healers used animal sinew to stitch up wounds and although more sophisticated materials are used today – from natural silk to synthetic dissolving thread – sutures remain the standard method for surgical closure.

Yet sutures can lead to infection, so alternatives such as surgical glues and adhesives are capturing an increasing share of the US$5 billion global market for such products.

Faster, better ... Professor Justin Gooding's work is changing the face of pathology

In response to design criteria established by surgeons, a team led by Associate Professor John Foster of the UNSW Bio/Polymer Research Group (BRG), in the School of Biotechnology and Biomolecular Sciences, is investigating potential applications of the world's first thin-film surgical adhesive that uses a unique combination of laser technology and biomaterials.

Known as SurgiLux®, it is a natural, environmentally friendly, strong, flexible film that is compatible with living tissue and is based on the US Food and Drug Administration-approved chitosan, a biomaterial derived from crustacean shells. The film is simply placed over a wound or surgical incision and activated with a conventional infrared clinical laser to effect closure. It is so unique, the Federal Government has awarded a grant to help its development for delicate brain surgery.

UNSW scientists are now working in collaboration with colleagues elsewhere to explore the potential for new biomedical materials and devices that may be more suitable not only for closing wounds but to effect other surgical joins and seals.

SurgiLux® has also been successfully applied in vivo to repair sciatic nerves in rats and has achieved results suggesting that it actually promotes healthy cell division and possibly even differentiation in some adult stem cells.

Thanks to a Fulbright Senior Scholarship, Professor Foster will spend four months of 2010 working in the US with leaders in the field of regenerative medicine, exploring the potential of SurgiLux® in this powerful new medical field.

Meanwhile, Professor John Whitelock and his team at the UNSW Graduate School of Biomedical Engineering have been working with the global medical products company HemCon to create the building blocks of a new generation of medical technologies.

Based on natural materials that promote blood flow, this research promises to have an impact from operating theatres to theatres of war.

They are investigating using chitosan to create synthetic vascular grafts and, ultimately, artificial blood vessels to help in the fight against heart disease.

"Our work is aimed at understanding how blood cells interact with chitosan . . . to enable us to develop a blood vessel in the laboratory."

The team is also investigating the wound-healing abilities of chitosan, used on the battlefield by US and Australian forces in haemostatic bandages.

While platelets attach to chitosan bandages, researchers are trying to understand what facilitates that attachment.

THE OPPORTUNITY

Licensing opportunities for SurgiLux® are available to industry. Research opportunities are available in all the schools mentioned. Scholarships are on offer at the Asia–Pacific Ubiquitous Healthcare Research Centre.

Medical marvels

Today's new breed of drugs use nano-technology to deliver dosages to the right place at the right time.

Photo Patrick Cummins

Developing better drugs is the pharmaceutical industry's holy grail. But better drugs have little therapeutic value unless they can be delivered to the right place in the right quantity at the right time.

The industry's new focus has become the targeted delivery of smart therapeutic agents.

Professor Neil Foster and colleagues at UNSW's Supercritical Fluids Group are pioneering the application of supercritical fluid technology to increase the solubility and bioavailability of several drugs.

Their focus has been the development of inhalable insulin. If it proves successful it could take the needle out of the management of type 1 and type 2 diabetes.

For a child with type 1 diabetes this would prevent them having to endure more than 20,000 insulin injections by the age of 15 years.

The Group's research also underpins plans by UNSW, the University of Queensland and Australian biotech company Prima BioMed Ltd to develop an oral vaccine for the prevention of cervical cancer.

Such a vaccine could reduce the incidence of cervical cancer, which claims more than 253,000 lives globally each year.

Nearly all cases of the disease are caused by infection with the human papillomavirus (HPV), which is typically transmitted through sexual contact. Injectable vaccines – such as Gardasil and Cervarix – guard against high-risk strains of HPV.

The availability of an orally delivered vaccine would address significant barriers to injectable vaccines, including their expense, requirements for repeated doses and sterile conditions, and patient fear and pain, which lead to poor patient compliance and compromised therapeutic effects.

The key challenge of this research is to encapsulate the vaccine so that it can safely pass through the body and be released to a target site in the body.

Accurate delivery of drugs is critical. Dr Pall Thordarson is an expert in the development of smart self-assembling materials aimed at more precisely delivering anti-cancer drugs to cells in the body and limiting their unpleasant side effects. If successful, this method could improve the survival rate and quality of life of chemotherapy patients.

"We are only starting to understand how these materials interact with living cells but this understanding will be essential for their use in medicine," says Dr Thordarson of UNSW's School of Chemistry.

"At the core of our work is our desire to understand how self-assembly works – the very mechanism nature uses to build life – and if we can grasp its power we should be able to tackle some of the key medicinal and environmental challenges in our society."

Dr Thordarson's work is part of a growing trend in chemistry and biomedical sciences to work with nature by mimicking biological systems perfected by evolution over millions of years.

Professor Rose Amal is developing magnetic gold nanoparticles that could help deliver anti-cancer compounds to tumours in the body.

The nanoparticles are clusters of iron oxide molecules sealed in gold. The presence of magnetic iron could allow potential therapeutic particles to be manipulated inside the body while gold's inert property provides an ideal surface for carrying drugs or biological monitoring agents.

Professor Amal heads UNSW's Particles and Catalysis Research Group in the School of Chemical Sciences and Engineering. The Group is also investigating the use of needle-shaped magnetic nanoparticles for gene therapy applications.

Stopping scars ... Professor Laura Poole-Warren

Other groups at UNSW are looking towards gene silencing, which would effectively knock out diseases entirely.

By targeting disease-causing genes and preventing them from being expressed in the body, gene silencing using siRNA (short interfering Ribonucleic Acid) has the potential to eliminate serious diseases such as cancer, AIDS and hepatitis.

Dr Volga Bulmus of the School of Biotechnology and Biomolecular Sciences, and Professor Tom Davis of the Centre for Advanced Macromolecular Design, are developing siRNA-based drug delivery systems which could take gene silencing from the lab to the hospital ward.

siRNA are molecular strands of chemical information, which interfere with or halt the expression of a gene in the body. While RNA interference is a natural process in living cells, scientists can tailor a component of siRNA to interfere with a chosen target gene, meaning siRNA could be used as a magic bullet to stop diseases in the first place.

But a magic bullet still needs a powerful and accurate gun. Dr Bulmus and Professor Davis, as part of a project with Associate Professor Maria Kavallaris from the Lowy Cancer Research Centre and Professor Heather Maynard at UCLA, are designing organic polymers which bond with a component of siRNA to create synthetic polymer-gene nanoparticles. The goal is to create nanoparticles robust and stable enough to survive the body's defences and deliver gene-based drugs to the site of disease.

"These molecules have huge potential," says Dr Bulmus.

"Using siRNAs we can silence any disease you can think of which is related to genes and with polymers we tailor them to overcome the various challenges involved."

Gene silencing can also help the body heal itself. Professor Laura Poole-Warren of the Graduate School of Biomedical Engineering is leading research focused on reducing damaging scarring around the sites of surgery.

By coating medical implants with siRNA that interrupts the expression of genes associated with scarring, the formation of scar tissue can be minimised.

One application of the research, being conducted with the Cooperative Research Centre for Polymers, is reducing the fibrotic scarring that occurs around surgical mesh used to prevent or repair hernias.

When meshes are placed into the abdomen, extensive scar tissue can form, causing the mesh to stiffen, buckle and rub on underlying organs. A common complication is more scar tissue forming onto the bowel and causing dangerous adhesions.

"We are interested in ways to modulate fibrosis around a material without changing the material, and that involves some form of surface modification," Professor Poole-Warren says. "The siRNA approach is a very flexible approach: you can produce a platform technology which is able to deliver a wide range of applications."

THE OPPORTUNITY

PhD scholarships are available through ARC Discovery funding held by Professor Davis and Dr Bulmus. PhD and post-doctoral opportunities are available in other areas.

UNSW technology researchers are building the next generation of super computers and speeding up the way we mine online information.

Quantum computing

Computer search technology

Self-guided farm machinery

Strengthening buildings

Robots

Satellite image technology

Next generation of flight

CHAPTER THREE:

CHANGING [TECHNOLOGY]

Photo Michelle Young, Lantern Studio

Need for speed ... Dr Andrea Morello (left) and Professor Andrew Dzurak

Quantum leap

A UNSW team working on the world's largest program in silicon-based quantum computing is starting to reap results.

A single quantum computer could, for some tasks, be more powerful than all the computers in the world today running together in parallel.

It's not simply speed and power that gives quantum computing the edge – it also offers vast advances in security over standard technology.

It uses the behaviour of subatomic particles – electrons and photons – to store and process data. The fundamental structure in quantum computer technology is the quantum bit or qubit. One type of qubit, being studied at UNSW, uses the "spin" of electrons associated with a single atom in the same way that silicon chip transistors use zeroes and ones to represent data.

Quantum computing's power comes from the fact that electrons can have a spin equivalent to a zero or one but, when coupled together, can deliver an exponential increase in their ability to represent data.

At UNSW, researchers have made important advances in creating and using qubits based on a single phosphorus atom embedded in silicon.

Silicon is not the only base material used in quantum research, but it offers the advantage of being widely used and understood in the computer industry.

Professor Andrew Dzurak is the NSW Node Manager for the Centre for Quantum Computer Technology (CQCT) and NSW Node Director of the Australian National Fabrication Facility at UNSW. He and Dr Andrea Morello, Manager of the Quantum Measurement and Control Chip Program, have recently achieved breakthrough results relating to the measurement of qubits.

"The key requirement for our silicon quantum bits is we need to control and measure the spin of an electron associated with a single phosphorus atom. We have been able to perform an important experiment making contact with those single atoms for the first time," Professor Dzurak says.

While a quantum computer that can outperform conventional computers is more than a decade away, Professor Dzurak says important breakthroughs are already being made, which will deliver "first-mover" advantage in related nanotechnology fields as well as lay the groundwork for large-scale computing.

The first commercialised quantum technology has already emerged in the area of secure communications. Quantum cryptography offers failsafe security and is attracting great interest for military and corporate financial applications.

The CQCT is the world's largest combined effort in silicon-based quantum computing and works closely with Sandia National Laboratories in the US and a number of other international centres. Its research is funded by the ARC, the NSW Government, the US National Security Agency and the US Army Research Office.

THE OPPORTUNITY

PhD and post-doctoral positions are available for research in silicon-based quantum computing, involving state-of-the-art nanofabrication, and low-temperature and high-frequency measurement facilities.

Photo Patrick Cummins

Out of the blue ... Professor David Taubman with his image compression software, Kakadu

Just browsing

Searching the web has become much easier thanks to technology developed at UNSW.

Do a Google search today and you will be using a search engine tool, known as Orion, developed by Ori Allon during his PhD candidature at UNSW's School of Computer Science and Engineering.

The program makes web searching easier by offering related terms to enhance a user's search and by displaying expanded text extracts in results, removing the need to click through to web pages.

Google was so impressed by Allon's work that in 2006 it bought the rights to Orion and hired its creator.

Allon says he was surprised by the job offer, but confident in his technology.

"For the most part, the concept is close to what I developed during my PhD. The primary difference is the complexity of the algorithm required for it to scale to serving millions of queries a day," he says.

Allon credits his success in part to his former supervisor, Dr Eric Martin, and Head of School, Professor Paul Compton, and says UNSW "definitely prepared me well for the commercial world".

Dr Martin says it is rewarding to see Orion integrated into Google's main search page.

"It's good publicity for the school and it demonstrates our students are ready for the real world," he says.

In the field of image compression, Professor David Taubman, head of the Telecommunications Research Group at UNSW's Faculty of Engineering, stands out.

A key contributor to the JPEG2000 international standard for image compression, Professor Taubman and US colleague, Professor Michael Marcellin, wrote what is considered the definitive textbook on the new standard.

To help demonstrate the more interesting features of JPEG2000, Professor Taubman, as an afterthought, wrote a program to include with the book.

That compression software, known as Kakadu, permits the rapid transfer of massive image and video files, and has become a hit in its own right. Kakadu lets users view an image or video at reduced quality, or with an arbitrary region of interest, while downloading only a tiny fraction of the file.

In this way the interactive multimedia browsing experience is simultaneously matched to the user's interests and the quality of the network connection, rather than leaving the user at the mercy of the way a web page was designed.

Professor Taubman says Kakadu is licensed to thousands of non-commercial users and among the 210 commercial licensees are some of the biggest names in the industry including Google, Disney and Warner Bros.

"It is very satisfying to see your work go into something very real," says Professor Taubman, adding he has no intention of stopping there.

"The great thing is that Kakadu is also a vehicle for getting other ideas we are working on out there."

THE OPPORTUNITY

Postgraduate coursework and research programs are available to suit a range of backgrounds.

Photo Grant Turner, Mediakoo

Perfecting pixels ... Associate Professors François Ladouceur and Martina Stenzel

Look who's talking

Everyday communication, from reading the newspaper to answering the phone, is about to change.

Electronic newspapers you can roll up and carry as easily as the printed version; cereal boxes displaying animated pictures; smart phones that can identify and ignore spam callers – such are the latest applications for communications technology.

Associate Professor François Ladouceur, Head of the Photonics and Optical Communications Group and Associate Professor Martina Stenzel, from the School of Chemical Sciences and Engineering, are developing a new generation of electronic paper or "e-paper" that is cheap, flexible and perhaps even disposable.

"This new breed of electronic display will be so flexible you can wrap it around things," Associate Professor Ladouceur says. "The winning technology is not yet available, but there is a whole industry out there waiting for the breakthrough."

The team are hoping their approach of utilising photonics and self-assembling polymer nanotechnology will give them the edge. The work has attracted the interest of UK company Plastic Logic which is a leader in the field of non-silicon, plastic-based electronics.

"Because the self-organising ability of the polymer eliminates the need for the expensive lithographic processing used in silicon-based displays, the process also promises significant reductions in costs," Associate Professor Ladouceur says.

"We've improved the technology and are now working on new ways of controlling the pixels themselves."

While this team is focusing on the printed word, for Dr Julien Epps it's all in the voice. Dr Epps, from the Speech Processing Research Lab, is part of a team of world leaders in the field of voice identification software.

The signal processing group, including Professor Eliathamby Ambikairajah, Dr Mohaddeseh Nosratighods and PhD student Tharmarajah Thiruvaran, was part of a consortium that ranked first in an international evaluation run by the US National Institute of Standards and Technology in 2008.

The UNSW group has continued breaking new ground and publishing work challenging the main method for characterising speech. The team has developed a piece of software – VoIP – that analyses digital speech waves and gives greater identification accuracy.

"Until now, one particular method of speech characterisation for voice identification has dominated the field since the 1990s and has been the mainstay of commercial systems," says Dr Epps.

"By adding our technique to the conventional method we can show a fairly significant improvement."

With voice identification increasingly being used in security, forensic, defence and commercial operations, the pursuit of greater accuracy is all-important. The breakthrough is already garnering international interest. The development may even be the saviour of householders battling spam callers.

"With the advent of VoIP telephony, one way of fending off spam telephone calls will be to use speaker identification to work out who is speaking before you let them through."

THE OPPORTUNITY

Postgraduate research work in speaker recognition, forensic voice comparison, emotion recognition from speech and new communications technologies.

Photo Grant Turner, Mediakoo

On track ... Dr Ray Eaton (left) and Associate Professor Jay Katupitiya

Good produce

Position is everything in the disparate worlds of nanomaterials and agriculture.

Associate Professor Jay Katupitiya is hoping the hardest decision farmers will soon have to make is which book to read while the crops are being sown.

As one of the research leaders behind the development of self-guiding tractors and robotic weeders and seeders, Professor Katupitiya believes autonomous agriculture can take the tedium out of farming while delivering greater efficiency and productivity.

The work of Professor Katupitiya and colleagues, at the School of Mechanical and Manufacturing Engineering along with Dr Ray Eaton, from the School of Electrical Engineering and Telecommunications, is being funded by the Australian agricultural industry. And industry has shown a keen interest in protecting the intellectual property already generated by this research.

The big-ticket item is a self-guided tractor that uses GPS and Inertial Navigation System data for navigation and computer software that steers and accelerates the vehicle.

The pinpoint accuracy needed to achieve automated farming in Australia's rough terrain is still to be mastered. In the meantime the team is developing a robotic planter fitted with sensors that can correct errors introduced by the tractor to deposit seeds at predetermined sites.

"If you control the planting and do that accurately, then the follow-up operations become easy," says Associate Professor Katupitiya.

"It becomes all about position. You are not interested in what you are going to kill when weeding, you are interested in killing anything that is in the wrong place."

Position is also everything in the field of nanotechnology. UNSW researcher Associate Professor Adam Micolich is about to delve into the field of nanowire research as part of an ARC Future Fellowship. Professor Micolich, part of the Quantum Electronic Devices Group within the School of Physics, is taking the group's leading-edge work of the past five to 10 years in nanoelectronics to see if it can be transferred across to semiconductor nanowires.

In contrast to most nanoelectronic devices, which are made by etching away at a large semiconductor chip, nanowires are self-assembled structures just 50 nanometres wide (a few-thousandths the width of a human hair) and up to several micrometres long.

His work will involve national and international collaborations with two of the world's leading nanomaterials groups, headed by ARC Laureate Fellow Professor Chennupati Jagadish at ANU and Professor Lars Samuelson at Sweden's Lund University.

"The materials aspects of nanowires are now becoming developed enough to start exploring their potential for new electronic devices. My interest is in looking at possible uses of these wires for spintronics – devices where the electron's spin rather than its charge is used for computing applications," says Associate Professor Micolich.

"The idea is that this takes what we've recently done at UNSW on developing whole quantum wires ... and transferring that knowledge to new materials."

THE OPPORTUNITY

Postgraduate research in the School of Physics, leading to a PhD or MPhil.
Postgraduate research in autonomous agriculture.

Photo Grant Turner, Mediakoo

Ahead of the curve ... Professor Mark Bradford

Concrete proposals

UNSW engineers are strengthening structures and manipulating precious metals to solve some of the built environment's biggest problems.

From the great domes of Europe to the bridges of Sydney, time is taking its toll on the materials that form our most iconic structures.

For Professor Mark Bradford, at the Centre for Infrastructure Engineering and Safety in UNSW's School of Civil and Environmental Engineering, overcoming the effects of age, acid rain and climate change is a challenge he is ready to accept.

Supported by an ARC Discovery Grant, Professor Bradford and colleague Dr Ehab Hamed, are developing an innovative retrofit approach that can strengthen domes with externally bonded composite materials.

Dr Hamed has already used the technology on masonry buildings in the Middle East with positive results.

Professor Bradford says the team has also had approaches from NSW Roads and Traffic Authority to see if the technology can be used on infrastructure such as bridges nearing the end of their life cycle, or which need strengthening to cater for increased traffic loads.

As part of their research they are also hoping to pioneer an innovative way of building thin curved or domed concrete structures.

In Australia, new dome construction, particularly from concrete, is rare because the structures face poorly understood stresses that can result in catastrophic failure.

The pair is using complex computer modelling to better understand the forces that can affect the integrity of curved concrete forms.

They have already built four-metre-diameter domes and tested these in the Centre's state-of-the-art heavy structures research laboratory.

With cement being the second-most used material on Earth next to water, Bradford says it makes sense to open up the architectural possibilities of the resource.

"Nobody previously had the expertise to do the mathematical modelling of concrete shells," says Professor Bradford. "We are now developing these models."

Dr Xuchuan Jiang, an ARC Future Fellow within the School of Materials Science and Engineering is dealing with a rarer resource to enhance capabilities.

He is looking at the functional properties and potential of low-dimensional nanostructures of metals such as gold, silver, platinum and metal oxides and in particular their self-assembly structures.

Dr Jiang hopes increasing knowledge of how these metals perform at the nano-level could lead to understanding how they can be manipulated to enhance their capabilities.

In particular Dr Jiang is working on developing new methods of encouraging self-assembly of these nanoparticles on a larger scale.

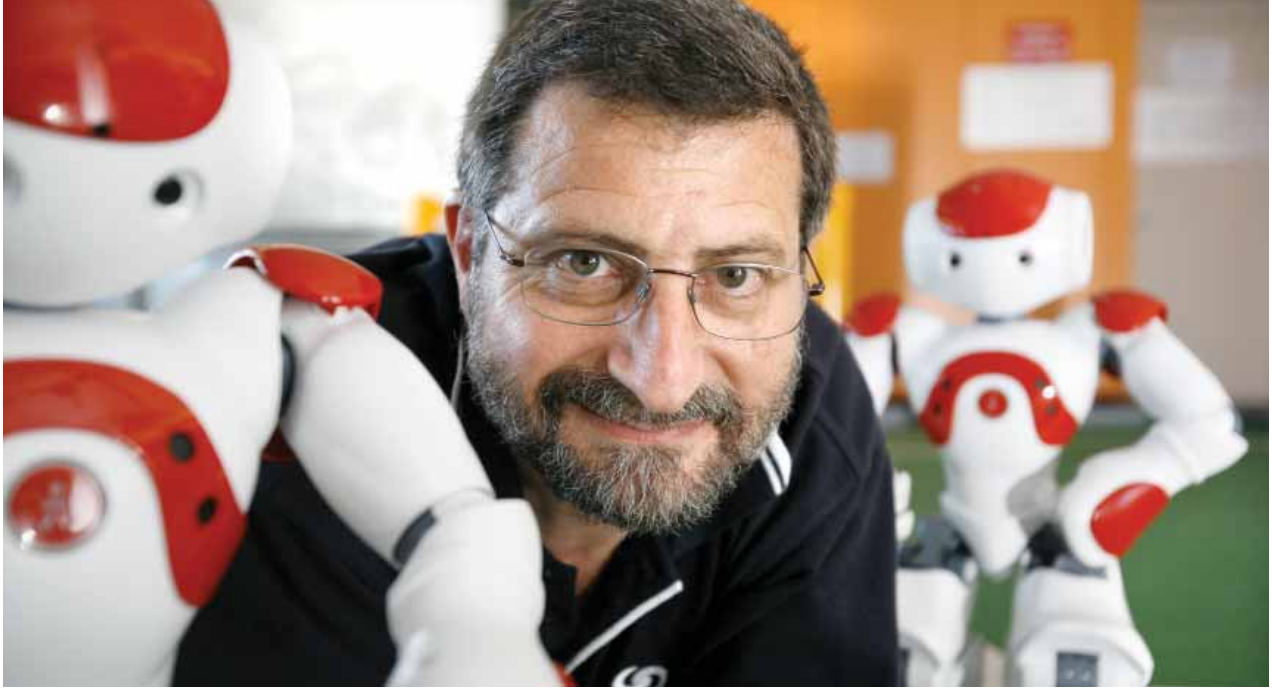
He hopes his findings will be useful in developing new and complex nanostructures for use in industry applications such as gas sensing, catalysts and lithium ionic batteries.

"This is not a very new field, but there are many challenges still," Dr Jiang says, adding his work could lead to high-capacity, low-cost and long life-span batteries that could help reduce greenhouse emissions.

THE OPPORTUNITY

Graduate research work leading to a Master of Engineering, Master of Science, Master of Philosophy or PhD is available, as well as coursework in the School of Materials Science and Engineering.

Photo Grant Turner, Mediakoo



Designing intelligence ... Professor Claude Sammut

Robots to the rescue

Fast-learning, intuitive and autonomous robots are coming closer to reality.

A robot that searches for survivors in a collapsed building and then maps the site for human rescuers to follow would make search and rescue missions far less perilous.

Making it actually happen is the goal of the Artificial Intelligence Research Laboratory, which is part of the ARC Centre of Excellence for Autonomous Systems.

The group at UNSW's School of Computer Science and Engineering has established an international reputation by harnessing the competitive spirit of its researchers in the creation of highly innovative robotic software.

Led by Professor Claude Sammut, the challenge has been to improve locomotion, navigation, sensing, decision-making and learning in robots that are used in real-life situations.

"The focus of most of our robotics research is the use of machine learning to help create autonomous systems," Professor Sammut says.

A rescue robot is taught how to drive over a simulated rubble field by capturing human input at a keyboard and then matching that with the images seen by the robot.

"This highly promising technique of learning by demonstration results in a robot adapting to unknown and changing circumstances," Professor Sammut says.

As well as working on rescue robots, the group is striving to develop general cognitive abilities of robots. Under the leadership of Associate Professor Maurice Pagnucco, Dr Alan Blair and newly appointed Future Fellow, Professor Michael Tielscher, the researchers are investigating new methods for programming and learning complex problem-solving behaviour.

The promise of making artificial intelligence work to greater effect while giving a richer interactive experience is the ambit of yet another lecturer at the school: Dr Malcolm Ryan.

He uses computer games to help elderly people who have suffered an injury rehabilitate their sense of balance. The work uses the same 3D vision technology of the rescue robots to monitor patients' body movement in the game.

"Rehabilitation exercises are usually dull and repetitive," Dr Ryan says. "We want to make them more motivating and fun by incorporating them into a computer game. It's called exergaming. Our current prototype is a maze game. Two players have to cooperate to pick up treasures in the maze. We've been playing it at a nursing home. People love it."

Other research by Dr Ryan focuses on more efficient control of the giant stevedoring robot cranes that move cargo around Australian ports.

He hopes the work will change the way these multi-tonne cargo robots operate so that more of them are able to move around without running into each other.

THE OPPORTUNITY

Several scholarships are available to students working towards a PhD or Masters by Research.

Photo Frederick J Brown, AFP, Getty

Among the ruins ... a survivor of the Sichuan earthquake

Damage control

Technology being developed at UNSW is helping improve responses to workplace and environmental disasters.

It's hard to imagine greater need for disaster risk management than in the aftermath of the devastating Sichuan earthquake and Victorian bushfires.

Researchers from UNSW's School of Surveying and Spatial Information Systems played a leading role in the earthquake recovery effort in China, using radar satellites to survey the ground movements in the quake zone after the disaster.

Under the guidance of Associate Professor Linlin Ge, the group was among the first in the world to generate a ground displacement map of the region, showing earth surface upheaval while identifying potential aftershock and landslide areas.

The School, headed by Professor Chris Rizoz, is today recognised as a world leader in satellite image technology.

The power of this technology was again revealed when bushfires ravaged Victoria in 2009.

The team was able to pass on to Victorian fire authorities high-resolution imagery of the fire zones by accessing data from Chinese satellites.

Scientists are now able to respond more effectively to disasters such as these because of a valuable new partnership between UNSW and a number of Chinese authorities.

This partnership will not only help Australian researchers monitor unfolding disasters, but will improve research capability on a range of environmental issues as well.

UNSW is also making a difference in another disaster zone with a team of more than 80 scientists investigating the impact of the Samoa tsunami and helping the government enhance its disaster risk-management strategy.

The team is being led by Associate Professor Dale Dominey-Howes, co-director of the Australian Tsunami Research Centre and Natural Hazards Research Laboratory, a global leader in the field.

This Centre, also headed by Professor James Goff, is unique in the region for its use of geologists, geographers, engineers, sociologists, policy scientists and ecologists to gain a holistic understanding of hazards phenomena.

At UNSW's iCinema Centre disaster risk management is all part of the game and its award-winning iCASTS – (iCinema Advanced Safety Training Simulators) – are attracting great interest.

The simulators are teaching mineworkers how to survive potentially life-threatening workplace hazards using virtual-reality mining environments.

Developed by UNSW's School of Mining Engineering in a seven-year collaboration with Coal Services Pty Ltd, the system re-creates hazardous situations through interactive training scenarios that are similar to a highly sophisticated computer game.

"Our research efforts are directed at developing new kinds of artistic experiences that can also inspire innovative industrial and commercial applications," says iCinema Centre director, Professor Dennis Del Favero.

They may not win an Oscar for their efforts, but the iCinema training technology could avert a mining disaster.

THE OPPORTUNITY

PhD and post-doctoral research opportunities are available, as are industry and government partnerships.

Photo Dr John Brackenbury, Science Photo Library

High fliers ... locusts might hold clues for researchers to develop microaircraft

With flying colours

The sky is the limit when it comes to aviation technology.

A dream of a microaircraft that mimics the flight of insects is more than just a flight of fancy.

Dr John Young, at the School of Engineering and Information Technology at the Australian Defence Force Academy (UNSW@ADFA), is using computer modelling to reveal how a locust's wings change shape during flight.

The work, carried out in collaboration with Oxford University researchers, has been published in the journal *Science*. The team used high-speed cameras to film the wing movements of locusts then fed the information into Dr Young's 3D model, which showed how the wing structure contributes to efficient flight.

The findings are, Dr Young believes, another step toward the creation of miniature aircraft.

"Certainly these aircraft are going to be fielded in the next decade. They're probably not going to be as sophisticated as nature's flyers but we will see them," Dr Young says.

And the work has real applications with the microaircraft already slated for deployment in areas as diverse as bushfire monitoring, search and rescue and industrial accidents.

Limiting aircraft noise and emissions in the wider world of aviation is also a focus of research at UNSW.

Dr Sameer Alam, another ADFA-based researcher, has developed the Air Traffic and Operations Management Simulator (ATOMS), the first system worldwide to integrate air-traffic modelling with data and computations on aircraft noise and emissions.

The system is used by Airservices Australia to study the environmental impact of air traffic procedures and is also the primary simulator in a study funded by the Eurocontrol Experimental Centre in Paris.

Simulation results from ATOMS show that savings of up to 30 percent are possible on fuel and have resulted in reductions in flying time, carbon dioxide emissions and noise.

"Many of the procedures aircraft now follow were developed in the 1970s without any real scientific thought," notes Dr Alam.

"We can use our system to work out optimal routes and change flight plans to minimise noise and emissions."

In the School of Mechanical and Manufacturing Engineering, Professor Don Kelly and colleagues are not concerned with how planes fly, but rather how they crash.

The team is looking at composite helicopter airframes and has developed models to predict how a frame might behave under stress, such as in an emergency landing.

"The particular response we are looking for is a crushing behaviour that maximises the energy that a structure can absorb," says Professor Kelly.

The researchers are working with Australian Aerospace in a program directed by the Cooperative Research Centre for Advanced Composites Structures. They hope to test the crashworthiness of a new generation helicopter structure in Germany in 2010. The knowledge the team is gaining on carbon fibre performance and failure in airframes is improving helicopter safety and positioning Australian industry to have world-leading design and building capabilities.

THE OPPORTUNITY

Postgraduate programs are open to civilians as well as defence personnel. Scholarships are available.

Researchers at UNSW are fighting for individuals' rights, working to sustain the fabric of our communities and helping people in developing countries.

Human rights

Green buildings

High-density housing

Welfare in the developing world

Mental health after the tsunami

Reducing drug harm

Emotional lives of men

CHAPTER FOUR:

CHANGING [SOCIETY]

Photo Patrick Cummins

Democratic defender ... Professor George Williams

The rights stuff

Anti-terrorism laws are posing major challenges for democratic nations.

Since the September 11 terrorist attacks, democratic nations have enacted security laws of stunning scope and number. War-like measures that were once unthinkable – detention without charge, heightened surveillance and new sedition offences – are now accepted as normal.

"The legal system has been fundamentally altered," says Anthony Mason Professor of Law, George Williams. "In the past these extreme powers were for conflicts like World War II which had a clear endpoint. But the conflict against terrorism has no endpoint.

"It's no longer an exceptional response to a transient threat, but a long-term shift in the way the law works," says Professor Williams, recently awarded an ARC Laureate Fellowship to investigate the challenge these laws pose for democratic nations.

The prestigious Fellowship gives Professor Williams, founding director of the Gilbert + Tobin Centre of Public Law at UNSW, the resources for a detailed comparative analysis of the scope and operation of the laws in countries ranging from Australia and New Zealand, to India, the UK and the US.

"Despite the volume of literature, much about these laws remains to be examined and understood," he says. "There is also the prospect that more laws will be enacted in response to further terrorist attacks, like those in Mumbai."

Also to be investigated is the "leakage" of exceptional measures into other areas of criminal law. "These measures ought to have been contained in the terrorism context, but they're turning up in anti-bikie legislation. That's a real concern," he says.

A second thrust of the research will address some of the thorniest issues in public law; namely the adequacy of oversight and review mechanisms to monitor the operation of the laws, and the ability of human rights mechanisms to protect individuals.

"This is especially important in Australia in the absence of a human rights act," Professor Williams says.

The weakness in human rights protections in Australia has been a long-term concern for UNSW's legal researchers. In 2005 Professor Williams chaired the Victorian Human Rights Consultation Committee, which led to the enactment of the first Charter of Rights by an Australian state.

UNSW has also been instrumental in the push for better protections federally. Professor Williams, along with colleagues Andrew Lynch, Ed Santow and Paul Kildea at the Gilbert + Tobin Centre, and Andrea Durbach and Andrew Byrnes at the Australian Human Rights Centre, wrote submissions to the Federal inquiry charged with determining whether Australia needed formal human rights protections.

Chaired by UNSW Visiting Fellow Father Frank Brennan, the inquiry recommended Australia enact a human rights act.

THE OPPORTUNITY

The Australian Laureate Fellowship has a strong focus on building and mentoring the next generation of PhD scholars. There are PhD opportunities for those interested in the area of Public Law.

Photo Angela Wylie, fairfaxphotos.com

High-density housing ... apartment living may not be suitable for all

Future proofing Australia

The findings of UNSW sustainability researchers are helping to shape critical public policy.

With the construction sector responsible for around 30 to 40 percent of our annual global greenhouse gas emissions, a climate emergency could be averted by making our existing buildings more sustainable.

"If we retrofit our existing buildings the energy we'd save would reduce the need for additional power stations," says Dr Peter Graham from the Faculty of Built Environment (FBE).

"Carbon emissions can be reduced by 30 percent with little cost to the economy and jobs can be created at the same time."

Dr Graham has spent the past two years with the United Nations Environment Program in Paris coordinating the Sustainable Buildings & Climate Initiative (SBCI). The SBCI aims to help "mainstream" sustainable buildings globally and assist the industry in rapidly reducing its greenhouse emissions. Much of the work Dr Graham was coordinating at SBCI was released at the UN Climate Change Conference in Copenhagen.

"Australia lacks a consistent framework for policy that sets regulatory targets for the industry, such as zero carbon or zero energy buildings, that could help us avoid the worst-case scenarios of climate change," says Dr Graham.

Researchers at the City Futures Research Centre (CFRC) believe that buildings not only have an effect on the environment, but also on their inhabitants.

"High-density housing may well be the answer to Sydney's urban sprawl but more than 50 percent of Sydney apartment dwellers are unhappy in their homes," the Centre's Director Dr Bill Randolph says.

He warns that the NSW Government's Metropolitan Strategy, which plans 640,000 new dwellings for Sydney – 70 percent of which will be high-density – will only work if apartment living is made more appealing.

"Planning assumptions based on an ideal type of apartment resident – young singles, couples and empty-nesters – don't sufficiently capture the complexity of the apartment population.

"The question is not whether more apartments are a sustainable option but whether increasing numbers of people living in apartments can be sustained," Dr Randolph says.

The nation's sustainability is also influenced by Australia's ageing population.

The proportion of Australians aged 65 and over is projected to almost double to a quarter of the population by 2050, leading to a huge drain on the public purse in the form of extended pensions.

The Australian Institute for Population Ageing Research (AIPAR) has launched the first nationwide Longevity Index designed to assess the effects of interest rates, inflation and longevity on the cost of self-funded retirement.

The researchers behind the index, the Australian School of Business's Professor Michael Sherris and Professor John Evans, say past modelling has underestimated the population's longevity in light of improved medical treatments – leaving many financial institutions scrambling to fund extended superannuation requirements.

"These are the types of things that we need to know and consider, when we're thinking about retirement decisions," says Professor Sherris.

THE OPPORTUNITY

The CFRC works in partnership with the community, government and business to contribute to the issues that impact on urban regions. Postgraduate research opportunities are available in FBE to urban researchers wanting to expand their skills. Postgraduate research opportunities are available in many areas of AIPAR's work.

Photo Ryan Pyle, Corbis

Struggling to survive ... an elderly woman cleans clams in Fujian province

A world of difference

From China to Papua New Guinea, UNSW researchers are working for the good of some of the globe's most vulnerable.

UNSW researchers are looking at welfare and economic issues affecting the two extremes of age in China.

At the Social Policy Research Centre (SPRC), Professor Ilan Katz and Dr Xiaoyuan Shang are looking at the extent, nature and cause of child abuse in China.

"Early findings reveal that most people in China would not do anything about child abuse because they think it's a private matter for the family," Professor Katz says.

"There isn't really a legal framework for them to intervene when a child is being abused so we need to help establish a new child welfare law and a system for responding to abuse."

Their research will lead to a raft of recommendations to Chinese government agencies.

At the other end of the ageing spectrum, Professor Peter Whiteford is helping forge an effective national pension system for the Asian giant.

The research provides a detailed description of the system over the past 30 years and assesses whether it has achieved its goal of social security for more people.

"Most of the population will remain dependent on old-age provision through family support for many years to come," says Professor Whiteford, also from the SPRC.

"The question is how do you create a pension system that gives people adequate incomes in retirement as the Chinese population rapidly ages?"

Closer to home, Associate Professor Heather Worth from the International HIV Research Group is helping stem the HIV epidemic in Papua New Guinea (PNG).

For the past three years, the UNSW team has worked with the PNG Institute for Medical Research implementing the HIV social research training program with 10 full-time, early-career researchers. This program coincided with the first national HIV research agenda and provided a pool of well-trained researchers where previously there were few.

"The HIV epidemic in Papua New Guinea is serious," says Associate Professor Worth. "The estimated prevalence is more than two percent in adults, making it one of the most HIV-affected countries in the Asia–Pacific region."

Associate Professor Worth's team is also evaluating programs to reduce the transmission of HIV to newborn children.

"This therapy is highly effective in preventing HIV among newborns, but in PNG many women ... do not come back to an antenatal clinic to receive this treatment and many babies die from AIDS-related conditions," she says. "Our research is aimed at finding out why."

While infection rates in PNG have not yet come down, the work of Associate Professor Worth and her colleagues is changing the way PNG responds to HIV – ultimately saving lives.

THE OPPORTUNITY

PhD and Masters by Research programs in social research, particularly in Asia and the Pacific.

Photo Dimas Ardian, Getty Images AsiaPac

Out of the shadows ... a survivor in Aceh remembers the tsunami

Healing power

When disaster strikes its impact is more than physical. Trauma is being dealt with by UNSW researchers using methods from psychiatry to the fine arts.

When the Boxing Day tsunami of 2004 rocked the Indonesian province of Aceh, it was just one more disaster in a decade of misery to strike the people.

In the aftermath of the killer quake, UNSW researchers joined with non-government agencies to help deal with post-trauma and the mental health impact of the catastrophe.

Yet it soon became apparent that the civil conflict and human rights abuses post-disaster, had mental health implications far outstripping those of the tsunami itself.

Examining this phenomena is a collaborative project between the UNSW Schools of Psychology and Psychiatry – under the stewardship of Australian Laureate Fellow Professor Richard Bryant, Professor Derrick Silove and Dr Zachary Steel.

The team is working with tsunami-displaced residents from the district of Barat – one of the worst hit areas in the disaster – doing a series of needs assessments and evaluations.

The ultimate aim is to develop whole-of-community programs that combine mental health and livelihood interventions to ease the trauma and poverty the people experience.

"Aceh has a strict Islamic tradition and that will be carefully taken into account in our research," says Professor Bryant. "We're putting a lot of effort into understanding local perceptions, idioms, terms and constructs to explain what's happened and how people cope.

"Essentially what we're trying to do is bring science to an international problem that traditionally has not been amenable to scientific study."

In recent years there has been a significant growth in trauma studies among cultural researchers.

The UNSW Centre for Contemporary Art and Politics at the College of Fine Arts, under the directorship of Professor Jill Bennett, has pioneered work on the study of trauma and its expression in art, particularly in relation to post-conflict communities.

Professor Bennett is involved in collaborative research projects with academics in The Netherlands, China and South Africa examining responses to epidemics and disasters.

She has worked with the University of Ulster on an exhibition that examines the trauma of dispossession in Northern Ireland, Indigenous Australia and South Africa.

"Much of our work focuses on dimensions of traumatic experience that are not readily expressed or represented in everyday language, but that needs to be addressed if a reconciliation or conflict resolution is to succeed," she says.

"In this sense, art or creative expression is vital to expanding understanding and analysis of the effects of trauma. It can even directly assist a reconciliation process."

THE OPPORTUNITY

Postgraduate research and PhD scholarships exist in many study areas. Clinical and forensic psychology postgraduate programs include intensive professional training.

Photo Bruce Magilton, Newspix

Big Day Out ... young people were asked about drug use

Risky business

Research into reducing drug harm is targeting a new generation of young people.

The number of people infected with hepatitis C in Australia is on the decline – a happy development for educators targeting injecting drug users about the dangers of sharing dirty needles.

But researchers warn a new generation of teenagers and young adults may be falling through the education net.

Research shows that despite the decline in overall Hepatitis C cases, infection rates are highest in people under 20.

According to an annual survey conducted at the Big Day Out concerts by the National Centre in HIV Social Research (NCHSR), one in four young adults aged between 16 and 25 is aware of injecting drug use among their friends but has minimal knowledge of how hepatitis C is transmitted.

"Around 83 percent of infections are caused by blood-to-blood contact through unsafe injecting practices yet a large percentage of young people surveyed thought it could be caught from sharing toilets or kissing," says Research Fellow Dr Joanne Bryant.

Dr Bryant says the study is unique because it captures young people before they start injecting. While most users contract hepatitis C within the first three years, less than 30 percent of young adults exposed to injecting knew where to access sterile needles.

"We need to be aware that injecting is a part of young people's social networks and that, if educated properly, they can share information with their peers about reducing the harms.

"This means we have to provide better education to school-aged kids in order to get that information to them before they start to inject."

Reducing drug harm is also the focus of another of the University's premier national research centres.

In the past 10 years the National Drug and Alcohol Research Centre (NDARC) has coordinated the Illicit Drug Reporting System and the Ecstasy and Related Drug Reporting System – Australia's largest drug-monitoring programs.

The programs report on the price, purity and availability of drugs and serve as an early warning system, identifying trends in illicit drug markets – essential information for governments, law enforcement agencies and health workers.

In 2009 the study revealed that crystal methamphetamine – or 'ice' – use fell across Australia, with NSW recording the steepest drop. This contrasted with a sharp increase in cocaine use by the state's injecting and recreational users. "In a perfect world we'd like to see decreases in all the drugs monitored," says Chief Investigator Dr Lucy Burns.

"We know people who are highly dependent on drugs are unlikely to stop, but at least we can focus on harm reduction by providing information for the implementation of targeted policies."

THE OPPORTUNITY

A comprehensive range of postgraduate research opportunities exist at NDARC and NCHSR.

Photo Patrick Cummins

Men's business ... Dr Clifton Evers explores the lives of surfers

Secret lives of men

The emotional lives of men are being revealed through UNSW research.

Among surfers a pat on the back can convey a wealth of meaning, while in retirement men often find their so-called golden years tarnished by loneliness.

These are just some of the insights into the secret life of men being revealed by UNSW researchers.

Social Policy Research Centre Research Fellow Dr Roger Patulny says while social contact in older age is vital for wellbeing, research shows men are often isolated – putting them at risk of depression and poor physical health.

Before retirement, men and women spend similar time with family and friends outside the household (70 minutes and 75 minutes respectively per day), he says.

But post-retirement men retreat to their families, spending just 53 minutes a day on social contact outside the home, while women spend almost double that time – 103 minutes – socialising outside.

"Retired men report a shift towards spending more time with partners – a finding strangely at odds with what women say," Dr Patulny says.

The impact is likely to be worse for men who are single, separated, divorced or widowed because of their lack of support, he says.

"I suspect that a lot of men would like to be more social in retirement, but they don't know how to make new friends out of the work environment," he says.

In contrast, surfing is predominantly the domain of younger men, who hang out in groups.

Until now, however, there has been little understanding of the bonds uniting devotees and their emotional lives.

Dr Clifton Evers – a lifelong surfer himself and Post-doctoral Fellow in the Journalism and Media Research Centre – debunks the idea of surfers as "straight as steel, strong as granite, austere and inviolate".

"Young guys hang out in tight-knit crews," he says. "There are strict pecking orders and through that they develop an emotional life.

"Intimacy is a very big part of their lives, so for instance getting a pat on the back from an older guy means much more than just hello," he observes. "It means you are bonded through shared experiences."

While young men might put surfing and their mates front and centre, they are still exploring their emotional lives.

"The way they have learned to talk about their emotional lives is by acting it out through a third object such as surfing, cars or sports stars," he says.

"They may talk about a mate and the experiences that he is going through, but really they are trying to work out what is going on for themselves."

THE OPPORTUNITY

Postgraduate research possibilities are available in journalism, media, cultural studies and social policy work.

UNSW research is changing the world – and so can you. Whether it's work on the environment, health care, technology or society, there is room for your input.

Partnerships
New research hubs
Making a difference
Fellowships
Prizes

CHAPTER FIVE:

ENGAGING WITH [RESEARCH]

Coming full circle ... OneSteel's Paul O'Kane with Professor Veena Sahajwalla

Industrial Strength

Strong partnerships between researchers and industry can take innovation to new levels.

Australian steel-maker OneSteel was putting its engineering cadets through UNSW when it was introduced to a novel research project in the Materials Science labs, which promised to take recycling to a new level.

Five years later, having steered the UNSW concept through industrial trials at its Sydney steel plant, OneSteel has turned Professor Veena Sahajwalla's idea into a reality.

What OneSteel Technical and Development Manager, Paul O'Kane, saw was a chance for a major steel company to make a significant environmentally friendly change. Electric arc furnace steel-making recycles scrap metal, so it is already an industrial-scale recycling process accounting for about 40 percent of steel production worldwide. But, it's also energy-hungry.

Professor Sahajwalla had discovered that waste plastic and tyres – which usually clog landfill around the world – could be "mixed in" with the coke and coal in an electric arc furnace, creating a cleaner, more efficient burn – and reducing the electricity required in the steel-making process.

OneSteel's Sydney and Melbourne plants are now manufacturing all their steel products, mainly for the construction industry, using the UNSW "polymer injection" green steel method.

"It was a very novel idea but the people in OneSteel wanted to do something environmentally friendly," says Mr O'Kane.

"With the added benefit of reducing electricity use, the potential to cut production costs, increase productivity and create a competitive advantage for an Australian-made product, in the face of imports, was also very high."

OneSteel has continued its cadetship program with UNSW, providing scholarships for undergraduates in the School of Materials Science and Engineering.

Mr O'Kane sees the tie-up as the right combination of educational, technical and industrial experience to build the company's next generation of managers. With the "green steel" collaboration, OneSteel not only opened its own plant up for industrial trials, but sponsored five extra PhD students to work on the research.

"We can do the research, but we can only get as far as proving our work in the lab," says Professor Sahajwalla of the crucial role of industry partners.

"You are always going to have people who look at something new and are a bit unsure. So, you need industry leadership, to believe in the idea and to convert it into a commercial reality."

UNSW's world-leading photovoltaics researchers will also benefit from a new link with the leading international supplier for the solar power industry, Germany's Roth & Rau AG.

The company will set up a state-of-the-art silicon solar cell production line on campus, in the $20m Solar Industrial Research Facility, the first solar research and development facility of its kind in Australia.

THE OPPORTUNITY

The ARC links academics and industry through Linkage grants. In 2009, UNSW won $17.4 million in ARC Linkage grants, which brought a further $31.5 million to the table in co-contributions from industry and other partners.

Photo Patrick Cummins

A grand vision ... the Lowy Cancer Research Centre at UNSW

New research hubs

Two new places of research, made possible by significant donations from philanthropists, will facilitate ground-breaking research at UNSW.

The **Lowy Cancer Research Centre**, officially opened in 2010, is the first research centre in Australia to bring together childhood and adult cancer research at the one site. The $100 million-plus facility houses up to 400 researchers from UNSW and the Children's Cancer Institute Australia (CCIA), making it one of the largest dedicated cancer research centres in the Southern Hemisphere.

UNSW is a leader in the field of adult cancer research with internationally recognised medical scientists such as inaugural Centre Director Professor Philip Hogg and Professors Robyn Ward and Levon Khachigian (see pages 18 and 19).

They are teamed at the new Centre with CCIA's renowned childhood cancer researchers, including Professors Michelle Haber, Murray Norris and Glenn Marshall.

The Centre's existence is in no small way due to the vision of businessman and philanthropist Mr Frank Lowy, whose family agreed to donate $10 million toward the cost of the new building - the largest single philanthropic donation ever received by the University.

A new energy research institute at UNSW, the **Centre for Energy Research and Policy Analysis** (CERPA), is providing a groundbreaking approach to fuelling our future in a clean, sustainable way.

The multidisciplinary Institute brings together the capabilities of seven UNSW faculties: Engineering, Science, Law, Arts and Social Sciences, Built Environment, the Australian Defence Force Academy and the Australian School of Business.

CERPA is the first place in Australia to cover all aspects of energy research – from renewable technologies and sustainable fossil fuel use to markets policy.

The institute will be housed in UNSW's flagship research facility, the Tyree Energy Technologies Building (TETB), which is due for completion in 2012.

The $125 million building is supported by $75m in funding under the federal government's Education Investment Fund and is one of the first such projects to get under way.

UNSW alumnus Sir William Tyree, after whom the building is named, has generously donated $1 million towards the building and pledged a further bequest of $10 million.

Photo FJMT Architects

Engineering a new future ... an artist's impression of the Tyree Energy Technologies Building, viewed from Anzac Parade

Leading the field

Photo Steve Lunam copyright Australian Museum

Major research prizes awarded in 2009

ENI Renewable and Non-Conventional Energy Award

Professor Martin Green
ARC Photovoltaics Centre of Excellence
(see pages 6 and 7)

Premier's Award for Outstanding Cancer Researcher of the Year

Professor Philip Hogg
UNSW's Cancer Research Centre
(see page 19)

Sir William Upjohn Medal

Professor David Cooper
National Centre in HIV Epidemiology and Clinical Research
(see page 16)

Australian Academy of Sciences Thomas Ranken Lyle Medal

Professor Victor Flambaum
School of Physics

Royal Society of NSW Edgeworth David Medal

Associate Professor Adam Micolich
School of Physics
(see page 31)

Eureka Prize for Scientific Research (sponsored by UNSW)

Professor Justin Gooding
School of Chemistry
(see pages 22–23)

Eureka Prize for Water Research and Innovation

Professor Brett Neilan
School of Biotechnology and Biomolecular Sciences
(see pages 12–13)

NSW Scientist of the Year Award – Environment, Water and Climate Change Sciences

Professor Brett Neilan
School of Biotechnology and Biomolecular Sciences
(see above)

2009 Khwarizmi International Awards

Professor Brett Neilan
School of Biotechnology and Biomolecular Sciences
(see above)

NSW Scientist of the Year Award – Physics, Earth Sciences, Chemistry and Astronomy

Associate Professor Linlin Ge
School of Surveying and Spatial Information Systems
(see page 34)

NSW Scientist of the Year Award – Engineering, Mathematics and Computer Sciences

Professor Gernot Heiser
School of Computer Science and Engineering and NICTA

Green Globe Awards – Sustainability Champion Category

Professor Stuart Wenham
ARC Photovoltaics Centre of Excellence
(see pages 6 and 7)

Celebrating at the Eureka Awards ... UNSW individual finalists (l–r) Professors Levon Khachigian, Justin Gooding, Brett Neilan, Associate Professor Greg Leslie and Professor Stuart Wenham. Not pictured: the team from the iCinema Centre

Royal Australian Chemical Institute RK Murphy Medal

Professor Neil Foster
School of Chemical Sciences and Engineering
(see page 24)

2009 Fulbright Senior Scholarship

Associate Professor John Foster
School of Biotechnology and Biomolecular Sciences
(see pages 22 and 23)

2009 Fulbright Professional Scholarship

Dr Vanessa Hayes
Children's Cancer Institute Australia for Medical Research

2009 NHMRC Academy (inaugural)

Professor Richard Bryant
School of Psychology
(see page 41)

2009 NHMRC Academy (inaugural)

Professor Bruce Brew
St Vincent's Clinical School

2009 NHMRC Academy (inaugural)

Professor Glenda Halliday
Prince of Wales Medical Research Institute

2009 NHMRC Academy (inaugural)

Professor Andrew Lloyd
School of Medical Sciences

2009 NHMRC Academy (inaugural)

Professor Mark Harris
School of Public Health & Community Medicine

Major Fellowships awarded in 2009

NHMRC Australia Fellowship

Professor George Paxinos
Prince of Wales Medical Research Institute

Professor Levon Khachigian
Centre for Vascular Research
(see page 18)

ARC Laureate Fellowship

Professor Richard Bryant
School of Psychology
(see page 41)

Professor George Williams
School of Law
(see page 38)

Photo Britta Campion

Making a difference

If you would like to collaborate with UNSW researchers and/or would like to explore the possibility of an industry partnership please contact:

Office of the Deputy Vice-Chancellor (Research)

The Deputy Vice-Chancellor (Research) is responsible for driving the strategic research direction, in particular, maintaining and advancing the University's profile in research and research training, as well as technology transfer.

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Office of Media and Communications

The Office of Media and Communications is responsible for the management of internal and external communications and handles all media liaison for the University.

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Email: j.brookman@unsw.edu.au
Web: www.unsw.edu.au/news/pad/articles/index.html

Students interested in pursuing a postgraduate research opportunity should contact:

Graduate Research School

The Graduate Research School is the central administrative and support unit for all students enrolled in PhD, MPhil and Masters by Research higher degrees at UNSW and their supervisors.

Phone: + 61 2 9385 5500
Fax: + 61 2 9385 6238
Email: enquiries.grs@unsw.edu.au
Web: www.grs.unsw.edu.au

For information on commercialisation possibilities please contact:

NewSouth Innovations

NewSouth Innovations Pty Limited (NSi) is UNSW's commercialisation arm and specialises in transforming research and technology developed at UNSW into successful ventures or products.

Phone: + 61 2 9385 5008
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Email: m.bennett@nsinnovations.com.au
Web: www.nsinnovations.com.au

UNSW Foundation

The UNSW Foundation Limited, a registered charity, is a company limited by guarantee. Registered in 1988, the company is linked to the University by a trust deed and is the principal vehicle for UNSW's fundraising activities. It oversees the raising of philanthropic gifts for scholarships, research and capital projects.

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