MASSEY RESEARCH

Imagining Antarctica
A fine artist ventures south

How to be the perfect host
Cell cultures and biotechnology

Calibrating molecular clocks
Calculating the speed of evolution

Research, Scholarship and Creativity

October 2004

Plus: Functional Foods • Volcanos and Risk • Mozart's Contemporaries

Massey University

Foreword

What is it that makes a university a university? Is it the legal right to bestow degrees? Perhaps, in part, but these days other tertiary institutions also confer degrees. The defining difference between universities and other education providers is the university's emphasis on research, research training and research-led teaching.

This definition of the role of universities has particular importance this year with the release of a Government discussion paper on the distinctive contributions of tertiary organisations. The New Zealand Vice-Chancellors' Committee also raised the level of debate with a comprehensive survey of public perceptions of universities. It came as no great surprise to find that nearly 90 percent of those surveyed regarded universities as the best place to study for higher degrees. However, it was significant and gratifying to learn that a similar percentage regard university research as important because it explores new areas of knowledge and is essential to New Zealand's global competitiveness.

Universities are made up of agglomerations of talented, curious individuals, eternally driven to explore and to make contributions to their academic domains. It is these individuals, many of whom you will meet in this publication, who attract research funding and are magnets for talented students, who in turn become the research leaders of the future – the explorers and, in some cases, the discoverers of new areas of knowledge.

Massey University's track record in exploration and discovery, particularly in agriculture and the land-based sciences, is a by-word. The University is committed to maintaining a strong research-oriented culture and to nurturing domains of excellence and future relevance. You will identify many of these areas of excellence (and emerging areas of excellence) in the pages of this publication. You will also find evidence of the value we place on research training and on ensuring that our academic staff have the time, support and equipment they need to achieve success. As part of this commitment, the University is home to New Zealand's fastest research computer, the Double Helix, and to New Zealand's most powerful nuclear magnetic resonance spectrometer.

As a forward-thinking and ambitious university, we are pleased when such investments pay off. For example, during 2004 we were again one of only three New Zealand universities to be listed in the annual Shanghai Jiao Tong rating of the top 500 universities in the world. The University was also pleased to report an increase of 30 percent in external research income for the year ended 2003, a very important indicator of research quality.

But rather than simply play the numbers game, we could focus on the power of one: Professor David Penny, who was awarded the Rutherford Medal for 2004 by the Royal Society of New Zealand. Professor Penny is known internationally for his studies in molecular evolution and mathematical biology, including the role of DNA in evolution.

He is a co-director of the Massey-based Centre of Research Excellence, the Allan Wilson Centre for Molecular Ecology and Evolution. Perhaps less well known is that he is also a superb role model and research trainer. He exemplifies the Massey University spirit.

I invite you to discover more research heroes in the pages of this new publication.

Judith Kinnear
Vice-Chancellor

Editor	MALCOLM WOOD
	m.wood@massey.ac.nz
Writers	TANE AIKMAN
	DI BILLING
	RACHEL DONALD
	KATHERINE FINLAY
	ADAM GIFFORD
	STEPHANIE GRAY
	KIM GRIGGS
	LUCY MARSDEN
	AMANDA MCAULIFFE
	JOSIE MCNAUGHT
	MALCOLM WOOD
Photographers	GRAEME BROWN
	MARK COOTE
	DIONNE WARD
Illustration	STEFAN MESSAM
Design	GRANT BUNYAN
Thanks to	AGRESEARCH
	TE PAPA TONGAREWA
	THE DOMINION POST
	THE NEW ZEALAND HERALD
	SIMON COLLINS
	ROD EMERSON
	RAY PREBBLE
	BRIAN WARD

For more information about the research in this publication contact:

Research Services
Tel +64 6 356 5120
Fax +64 6 350 5690
Email: researchservices@massey.ac.nz

For information about the commercial application of Massey University research contact:

Massey University Commercialisation
Tel +64 6 350 5135
Fax +64 6 350 5690
Email: G.J.Clark@massey.ac.nz

For media enquiries contact:
Public Affairs
Tel +64 6 356 5095
Fax +64 6 350 5786
Email: editor@massey.ac.nz
www.massey.ac.nz

Celebrating research

Massey University has a proud research tradition which dates from its very beginnings as an agricultural college. Mementos from Massey's early years live on in such things as the Drysdale and Perendale sheep breeds, named after Massey staff Dr Francis Dry and Sir Geoffrey Peren respectively.

Today Massey remains a power to be reckoned in both the biotechnology and land-based sciences, but, as you will see in these pages, over the last 76 years Massey has evolved to become much more. It is now a large, modern university with a robust multi-campus, multi-modal structure. It embraces a remarkable range of expertise, and with a track record of problem solving it is uniquely equipped to contribute to New Zealand's economic, cultural and social development.

At the core of the University lie academic excellence, scholarly endeavour and research, both pure and applied. Year on year Massey's already considerable research outputs – such things as its research income, research degree completions, and the commercial application of its research – have grown impressively. For this Massey can only thank its staff. In turn the University is committed to supporting and celebrating their endeavours.

The University publishes research reports, which are distributed to our stakeholders and, for a more general audience, we publish news on our website, in *Massey News*, and in the alumni and friends magazine *MASSEY*.

This inaugural research magazine brings together some of Massey's researchers – some relatively new, others long established – and a sampling of their work and achievements. However, it is no more than a selection. There are many other achievements that deserve to be marked and many other individuals who merit celebration. In future publications you will meet more Massey achievers.

I hope you enjoy this publication. Whether you have interest in the molecular structure of viruses, in how to keep New Zealand free of foot-and-mouth, or in learning something about 18th century music, you'll find something here. You will also find a collection of remarkable individuals. Like the University they are part of, they are committed to making a positive difference.

Professor Nigel Long
Assistant Vice-Chancellor - Research

New Zealand's most powerful NMR spectrometer arrives

New Zealand's most powerful NMR (Nuclear Magnetic Resonance) spectrometer is lowered into place in July 2004. The 700 MHz spectrometer allows the structure of molecules such as proteins to be resolved.

Contents

Supercomputer boosted


Professor Peter Schwerdtfeger

In mid-2003, when the switch was flicked, the parallel computer on the Albany campus became, for a while, the most powerful computer in the country. But since then technology has moved on and an upgrade has been in order. The computer, christened Helix, is to become the Double Helix, again seizing the laurels as the country's fastest computer outside the private sector.

Parallel computers work by yoking together many processors. The current Helix computer is built around 32-bit 66 dual Athlon processors. Now a cluster of 64-bit AMD Opteron 250 processors are being added. There will be a master node with 16 Gb RAM and 19 slave nodes each with 4 Mb RAM. Each node will have dual processors and two 120 Gb hard drives.

Part of the reason for upgrading the Helix is the arrival on Albany campus of a new member of staff: the world-class theoretical chemist Professor Peter Schwerdtfeger. The presence of Professor Schwerdtfeger, who had been with the University of Auckland, has attracted seven other scientists who together make up an eight-strong group of theoretical and computational chemists and physicists. In collaboration with scientists in Paris, the group is investigating phenomena such as the left and right 'handedness' of molecules, and the Double Helix is expected to be very useful.

The Double Helix, like the Helix before it, will also be heavily used by the Allan Wilson Centre for Molecular Ecology and Evolution.

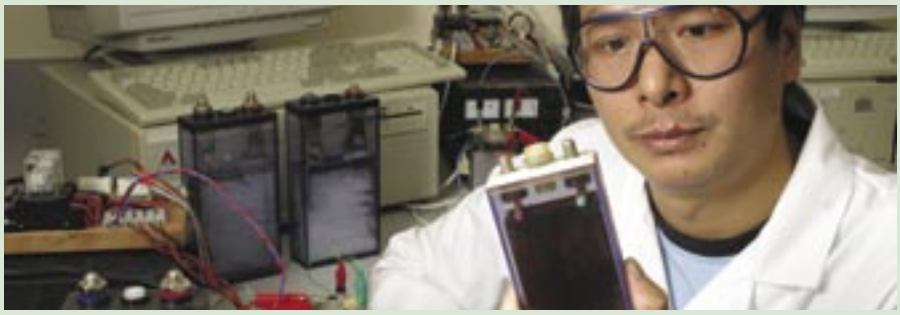
Battery advance funds research centre

The Anzode Research Centre is one outcome of a deal struck between the University and a group of United States-based investors to commercialise a new zinc battery technology developed by chemists Drs Simon Hall and Michael Liu.

The two have discovered a chemical answer to a problem that has plagued developers of rechargeable zinc batteries: creating long-life zinc-based anodes.

The group of investors is led by Chris Officer, a Massey graduate now living in California. Anzode, a company formed to purchase the licensing rights to the technology and to market the technology to international battery manufacturers, is also funding the establishment of the research centre for Dr Hall and Dr Liu's work.

Drs Hall and Liu had put their academic careers on hold to protect the intellectual property of their discovery. "This is a challenge for academics. They have to decide not to publish their work if they want to take it to market. We hope this partnership will show it can work."


Dr Michael Liu.

$450,000 towards synchrotron

The University has committed $450,000 over the next three years to the Australasian synchrotron beamlines project. New Zealand's overall contribution to the synchrotron will amount to $5 million, with half of the investment coming from the Government and the remainder from universities, CRIs and industry. Massey's contribution is approximately 14 percent of the New Zealand consortium's contribution – the second largest from a New Zealand university. The Victorian Government, universities and research institutes are investing more than $20 million in the facility, which will be up and running in 2007.

A synchrotron creates beams of extremely intense light (a million times brighter than the sun or conventional lab equipment) that can be used for many different types of research simultaneously. The high-energy light streams are directed through beamlines to carry out research in biotechnology, medicine, environmental sciences, agriculture, mineral exploration, materials development, engineering and forensics.

Professor Geoff Jameson of the Institute of Fundamental Sciences says access to the synchrotron will benefit areas of research across the University. "It's a truly multi-use piece of equipment. It will transform basic science and applied science as well. It can be used not just for blue skies research but also in fields like engineering and technology. With any process which needs light, the synchrotron will do it better – from hard X-ray light through to infrared."

Massey University will act as an external peer reviewer to the project team.

Commercial diagnostic lab sited with IVABS

The Institute of Veterinary Animal and Biomedical Sciences (IVABS) now hosts the southern North Island's centre of New Zealand Veterinary Pathology, a commercial veterinary diagnostic laboratory.

This relationship is expected to enhance the student learning experience and lead to greater opportunities for research in such critical fields as disease control and biosecurity.

New Zealand Veterinary Pathology (NZVP) will carry out a range of diagnostic tests. It incorporates the existing facilities and expertise of the IVABS clinical pathology laboratory, but with access to more diagnostic material and surveillance information. The laboratory will enhance teaching and learning experiences for medical, laboratory science, veterinary and nursing students. It will enable the University to gain access to material for research and allow IVABS to make a greater contribution to national biosecurity.

Head of IVABS, Professor Grant Guilford, says the new partnership will increase the critical mass of pathology expertise on the campus.

He says the siting of the diagnostic laboratory within the University is based on overseas models, where the state diagnostic laboratory is closely intertwined with an academic veterinary programme, such as at University of California - Davis and Cornell.

IVABS will continue to have positive relationships with other commercial diagnostic pathology groups.

Another New Zealand Veterinary Pathology centre will be sited in Hamilton.

Pod measures body fat and lean muscle mass

The Institute of Food, Nutrition and Human Health has purchased New Zealand's first Bod Pod. The space capsule-like pod measures body fat and lean muscle mass using air displacement technology, replacing the use of tape measures, callipers, and water displacement tanks.

"'Dunk tanks' were very claustrophobic," explains Dr Jane Coad. "The pod is much more suitable for children, disabled people and pregnant women. The subject sits in the pod in their togs and the difference in volume of the chamber, before and after the subject gets in, is measured precisely giving an accurate volume. The process takes about five minutes."

Once the volume and weight of a person are known, the proportion of fat and lean tissue in their bodies can be calculated, as can the visceral body fat around the abdomen.

"Obesity is increasing dramatically in New Zealanders of all ages. The incidence of metabolic syndrome, type 2 diabetes and heart disease are all affected by obesity. However, body fat can vary in its distribution and effects. Visceral body fat around the abdomen is more harmful than peripheral body fat, particularly that distributed around the hips and thighs. This is the reason why a pear-shaped body is considered to be healthier than an apple-shaped body. The Bod Pod will allow us to differentiate between different types of body fat and assess health risk."

The Bod Pod will further enhance the University's growing capability in the area of metabolic syndrome – the pathological state that insulin resistance is part of – as well as in the field of body composition, and specifically the loss of muscle tissue over time.

"As people age, their overall metabolic rate falls and they lose muscle mass and bone mineralisation. Although the reduced density of the skeleton renders the bones more vulnerable to fracture, it is the gradual erosion of muscle mass, known as sarcopenia, and the ensuing frailty, that leads to falls. The determination of body composition in the elderly is made complex by simultaneous changes in fat and muscle mass. The Bod Pod will allow us to measure body composition in older people much more reliably."

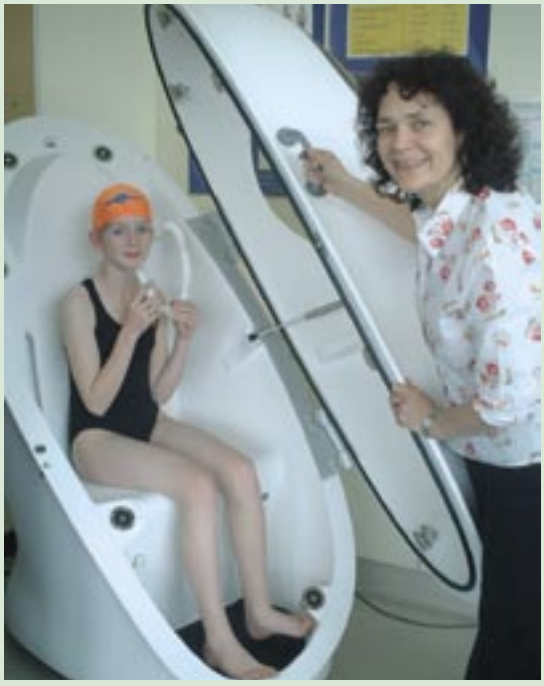


Photo courtesy of *The Dominion Post*

Rotary dairy shed opens

A $1 million rotary dairy shed has been opened on Massey's Palmerston North campus. The new 50-bale dairy shed, based on a DeLaval milking system, has all of the latest trimmings: computer-controlled systems, electronic cow identification, automated cup removal and automatic washdown on the backing gate. The shed is the third in a succession that began when Massey Agricultural College opened a herringbone shed in 1952. The then-revolutionary shed cost £1,100. In 1973 a 36-bale rotary shed was opened at No. 4 dairy farm. This was one of the few rotary sheds in the country, and one of the biggest, catering for what was a 'large' herd of over 300 cows.

Today there are 3.7 million cows in New Zealand. The dairy industry is worth $5.6 billion to the country and accounts for up to 20 percent of exports.

New boat for marine researchers

Thanks in part to the philanthropy of a local businessman, the Massey Coastal Marine Research Group has a new boat – a sturdy 5.6 metre Stabi-Craft – in which to ply the waters of the Hauraki Gulf. The bright yellow Aronui Moana was launched off Brown's Bay Beach by the Deputy Vice-Chancellor of Albany campus, Professor John Raine.

Local businessman Craig Lewis, director of Hibiscus Coast-based GulfLand Marine, provided sponsorship in the form of a 90hp Mercury engine and the installation of electronics by Humminbird Electronics.

The Coastal Marine Research Group is based at Albany campus. Led by Dr Mark Orams, the small group draws expertise together from a number of disciplines, including marine biology, meteorology, international business, statistics, heritage management and sports management.

One of the group's projects centres on studying the behaviour and ecology of dolphins in the region, and the effect tourism has on them.

AgResearch relocation welcomed

AgResearch's decision to move its animal health research team from its Wallaceville site to the University's Palmerston North campus is expected to benefit both organisations.

"This relationship will lead to the formation of a national centre of animal health research of a size and expertise that rivals that found anywhere in the world. The move will effectively double the number of fulltime staff equivalents researching animal health on the campus," said Professor Grant Guilford, the Head of the Institute of Veterinary, Animal and Biomedical Sciences.

"A recent international comparison by the Government and Royal Society has confirmed that research in veterinary and agricultural science is one of the few subject areas in New Zealand that has a relative international impact above the world average. The capabilities of Massey and AgResearch are complementary in these subjects."

The University has agreed to build a $14 million dedicated facility, adjacent to the IVABS tower, to be leased to AgResearch. A jointly managed research institute will be set up to facilitate collaboration.

Professor Guilford says while it is understood the move will be disruptive for the Wallaceville staff and their families, they will be made welcome in the Manawatu. "We are positive this partnership is necessary for the long-term health of animal health research in New Zealand."

"This additional expertise will also help propel the production animal aspects of Massey's veterinary school comfortably into the top 10 veterinary schools in the world – an élite ranking no other professional programme in the country can claim."

For their part, the AgResearch staff will be able to access the expertise in the nation's only veterinary school in fields as diverse as clinical sciences, animal production systems and epidemiology, as well as the world-leading fundamental research being undertaken across the College of Sciences into such things as genomics, proteomics and nanomaterials.

The grouping of research staff will also mean better return on capital investment in research equipment and facilities.

Particle flow meter licensed

A licence to manufacture a particle flow meter that applies a technology developed by Massey University Professor of Particle and Process Engineering Clive Davies has just been signed with an Australian company for use in the mineral processing industry. The mineral processing applications of the patented Slotway™ Technology have just been licensed to JKTech Pty, the commercial arm of the Julius Kruttschnitt Mineral Research Centre, Queensland, Australia. Partners for other applications of the Slotway™ Technology are being sought in several high-value industries, particularly food and pharmaceuticals.

The Slotway™ Technology measures the flow rate of granular or powdered material. While there are some alternative measuring devices on the market, these are unsuited to many industries. "Our system is very accurate, very robust and very simple," says Professor Davies.

Professor Davies began thinking about the Slotway when working with casein in the dairy industry in 1985. The first patents were taken out in the early 90s and the technology is now patented in New Zealand, Australia and the United Kingdom. Its first application was as a portable device to measure the flow rate of grain for an Adelaide company. "It was a big machine working with big quantities – up to 80 tonnes per hour. I believe the technology is almost infinitely scaleable from several grams per second to hundreds of tonnes per hour."

Professor Davies is a recent arrival at Massey after 24 years with Industrial Research Limited (formerly DSIR). When he came, he brought with him a portfolio of patent-protected technologies with almost immediate industry applications. The University negotiated an agreement with IRL to acquire the Intellectual Property rights and led to the commercialisation of the technologies as part of an on-going collaboration in which financial returns are shared.

Profits in the pipeline

CleanFlow Systems, run by brothers Geoff and Trevor Logan, is one of the first companies to graduate from the e-centre at Albany.

CleanFlow is producing a technology that accurately profiles underground pipes from the inside. The system, the ClearLine Profiler, uses a laser profiler mounted on a mobile video camera. The laser profiler projects a ring of light which travels along a pipe's inside surface registering imperfections as it goes.

More than 50 of the recently developed $20,000 profilers have been sold, with orders coming from Germany, Australia and the United States.

Some part of the company's success can be attributed to Dr Martin Johnson, from the Institute of Information and Mathematical Sciences, who was able to help the Logan brothers when they were struggling to keep the infrared beam on their prototype profiler centred in the pipe.

The ClearLine profiler meets the unexpected in a Florida pipe.

Dr Martin Johnson with Paul and Trevor Logan.

The New Zealand Centre for Ecological Economics launches

A boat sinks off the New Zealand coast and an oil spill envelops the shoreline. Is this a gain to the New Zealand economy? Strangely, by some measures, such as Gross Domestic Product, it quite possibly is. But while tens of thousands of dollars spent on the clean-up are measurable economic activity, the damage to the ecology is missing from the balance sheet.

So Dr Murray Patterson favours not GDP, but a GPI or Genuine Progress Indicator, as a measure of how well New Zealand is doing. GPI factors in the value of New Zealand's natural resources and biodiversity. The oil spill that lifts GDP would likely cut GPI.

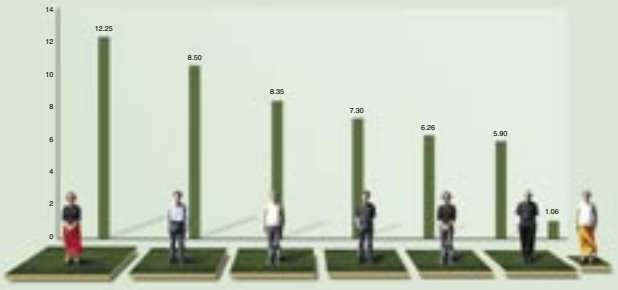
Dr Patterson is the director of the newly formed New Zealand Centre for Ecological Economics, a collaboration between Massey University and Landcare Research Ltd.

Funded by a Foundation for Research, Science and Technology grant of over $6.1 million, the Centre has embarked on two major research projects. The first, *Sustainable Pathways*, will assess the resource consumption, pollution levels and environmental impact of three centres: Auckland, Christchurch and Nelson. Using Geographical Information Systems (GIS) and computer modelling it will then be possible to explore various scenarios. What would happen if, for example, Auckland were to choose to reduce its carbon dioxide emissions? What would be the economic impact and which industries would be most affected?

The second research project, *Ecological Footprint Plus*, will identify the issues surrounding sustainability in land-based industries such as farming and forestry. It will be carried out in collaboration with Wool Research NZ and NZ Forest Research.

"A product like butter uses resources and generates pollution at each step along the production chain," explains Dr Patterson. "The production of butter includes inputs of petrol, pesticides and fertiliser needed to produce the milk on the farm, and then the inputs of resources needed to process the milk into butter."

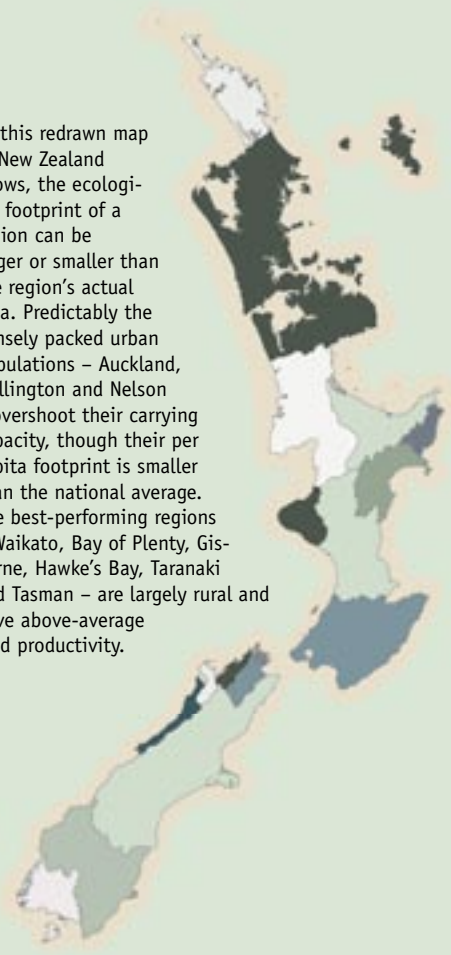
Just as New Zealand now labels whiteware with energy efficiency ratings, in countries such as Germany and the Netherlands there are a well-established systems of product labelling certifying environmental impact. Although there are currently no plans for New Zealand to follow suit, measures of environmental impact may still prove useful in changing the behaviours of producers and consumers.



In 2002 the Ministry for the Environment commissioned Dr Murray Patterson and Gary McDonald to assess the ecological footprint of New Zealand and its regions.

Patterson and McDonald found New Zealand's ecological footprint equated to 11,685,000 hectares. This is 65.7 percent of the 17,784,000 hectares of usable land that remain once national parks, forest parks, reserves and unproductive land are subtracted from New Zealand's land area. New Zealand, it turns out, is one of the few developed countries living within its carrying capacity and, in this sense, falling within the definition of a sustainable economy. (Canada and Australia are others.)

Individually, however, New Zealanders do not fare so well. The per capita ecological footprint of each New Zealander expressed in land area is around 3.08 hectares, or around 4.4 rugby fields. However, this is a local measure and no fair basis for ranking us against other nations. To make a just comparison, our footprint – and the footprints of the nations we are ranked against – must be adjusted to take into account land productivity differences. With this done, New Zealand's per capita ecological footprint rises to 8.35 hectares.



As this redrawn map of New Zealand shows, the ecological footprint of a region can be larger or smaller than the region's actual area. Predictably the densely packed urban populations – Auckland, Wellington and Nelson – overshoot their carrying capacity, though their per capita footprint is smaller than the national average. The best-performing regions – Waikato, Bay of Plenty, Gisborne, Hawke's Bay, Taranaki and Tasman – are largely rural and have above-average land productivity.

Professor Neil Pearce

PCP exposure

Ongoing health problems among timber workers exposed to industry chemical PCPs are to be investigated by the Centre for Public Health Research, led by Professor Neil Pearce.

The project, funded by the Ministry of Health, is intended to ascertain whether timber workers exposed to PCPs (pentachlorophenols) are dying earlier, getting cancers more often and suffering more chronic health problems.

Professor Pearce says the study addresses concerns expressed by former timber workers in the past decade about a range of chronic health problems they have experienced – including fatigue, nausea and neuropsychological dysfunction.

"These workers were exposed to PCPs through its use as an anti-sapstain fungicide in sawmills. Because of uncertainty over whether these health problems could be attributed to past PCP exposure, the Government has made funding available to commission research aimed at clarifying the issue," he says.

Administered by the Health Research Council, the $520,000 study will compare timber workers' death rates with national rates, and will estimate the size of any risks attributable to PCPs. It will also involve a survey of current health problems in a random sample of former timber workers. The project advisory committee includes representatives of the Forest Industries Council, the unions representing former timber workers, Sawmill Workers Against Poisons (SWAP), the Ministry of Health, the Ministry for the Environment, ERMA and OSH.

Serum samples will be taken from a random sample of former timber workers to validate exposure. Workers involved in wood treatment processes or in handling treated timber are known to have significant exposure to PCPs. Jobs with potential for heavy exposure include handling of sludge formed in the bottom of dip tanks and any process involving the heating of PCP, including burning treated wood or welding structures contaminated with PCP.

From the 1950s through to the late 1980s PCP was widely used in the New Zealand timber industry, and almost all freshly sawn timber was treated to prevent sapstain fungi. The Department of Conservation estimates almost 600 sites in New Zealand are contaminated.

The organic chemical can be released into the atmosphere from treated wood and transported to surface water and soils. It is also released into the atmosphere from factory waste disposal, entering the soil as a result of spills, disposal at hazardous waste sites and its use as a pesticide. The compound can be present in fish or other food species, and its levels are monitored by the USA Food and Drug Administration.

People are exposed to PCPs through contaminated drinking water, the inhalation of contaminated air and through the handling of treated timber, textiles, leather and paper products. PCP is completely and rapidly absorbed by the digestive tract, where it enters the bloodstream, and accumulates in highest concentrations in the liver, kidneys and brain.

Professor Pearce was part of a team to undertake a preliminary study of the effects of occupational pentachlorophenol exposure for the Wellington Medical Research Foundation in 1998. He says the current project work fits well with the increasing number of other occupational health projects under way at the Centre.

These include research on occupational causes of bladder cancer, leukaemia, non-Hodgkin's lymphoma and nasopharyngeal cancer; studies of cancer in workers exposed to dioxin pesticide production or through work in pulp and paper mills; the work on occupational health in Māori being carried out by Professor Chris Cunningham at Te Pumanawa Hauora; and research on shiftwork and fatigue by Professor Philippa Gander at the Sleep/Wake Research Centre.

$8 million to build social science capacity

The University is hosting an $8 million project with a network of New Zealand's leading social scientists.

The funding awarded to the Aotearoa New Zealand Social Sciences Research Network is the largest single investment ever in a social science project in this country. The funding follows the Tertiary Education Commission's 2003 announcement of a programme to build research capacity in the social sciences.

The network of eminent social scientists will be led by Massey's Professor Paul Spoonley and hosted by the College of Humanities and Social Sciences. Professor Spoonley and his Massey colleagues will be working with researchers from the University of Auckland, University of Canterbury, Lincoln University, Victoria University, Waikato University and the Family Centre in Lower Hutt.

The network will receive $1.5 million each year for the next five years, and has also been granted a further $500,000 to cover upfront capital costs. The funding will be used to develop research capability and to encourage and mentor new research.

The project was launched by the Minister of Education (Tertiary), Steve Maharey. He says it is an excellent example of tertiary education institutions working collaboratively in the way the Government's Tertiary Education Strategy intends.

"New Zealand has enormous research talent in the social sciences but hasn't been able to build capacity up until now. This project will make a huge difference to that."

Professor Spoonley says the initiative represents a unique opportunity for the social science community to contribute to the future well-being of all New Zealanders.

"New Zealand has become a more confident society that wants to shape its own future. It is very important to our future that we have good social scientists who can contribute to developing policies that work in the 21st century," Professor Spoonley says.

The Aotearoa New Zealand Social Sciences Research Network pulls together a portfolio of 36 existing research projects with the intention of extending them into new areas based on themes of:

- new wealth creation and distribution systems in a globalised context
- social justice and development
- transmission of wealth/knowledge in a context of demographic change
- sustainability of diverse households, communities and settlements.

The collaboration will be further enhanced by extending links with key government departments and communities, sharing information online, and regular workshops. Pro Vice-Chancellor of the College of Humanities and Social Sciences, Professor Barrie Macdonald, says the University's selection as a host confirms its standing as a centre for social science research.

The Minister of Education (Tertiary), Steve Maharey, at centre, stands flanked by members of the Aotearoa New Zealand Social Sciences Research Network. Left to right: Dr Charles Waldegrave (Family Social Policy Centre, Lower Hutt), Professor Richard Bedford (University of Waikato), Professor Sally Casswell (SHORE, Massey University), Professor Paul Spoonley (Massey University), Hon Steve Maharey, Dr Jenny Neale (Victoria University of Wellington), Associate Professor Robin Kearns (University of Auckland), Professor David Thorns (University of Canterbury), Professor Jacques Poot (Waikato University).

2004 Marsden grants

Six Marsden grants and five Fast Start grants have gone to Massey researchers as part of the 2004 Marsden funding round. The Marsden grants support established researchers; the Fast Start grants (see pages 17-19) are intended to help promising researchers at the beginning of their careers. The fund is administered by the Royal Society of New Zealand.

Professor Barry Scott and his colleagues will study the role of reactive oxygen species in controlling growth and development of plant symbiotic fungi. By-products of oxygen have long been recognised as important for cellular defence against pathogens. Both mammals and plants respond to pathogen attack with an oxidative burst that generates high levels of reactive oxygen species such as hydrogen peroxide and superoxide, which kill the pathogen. Recent work has shown that these same molecules play an important role in animal, plant and microbe development, but the mechanism by which this is achieved is unknown. Research from Professor Scott's lab has recently shown that fungal production of reactive oxygen species appears to be crucial for controlling the growth and development of plant symbiotic fungi. Professor Barry Scott, Dr Aiko Tanaka and Dr Simon Foster receive a Marsden grant to investigate how these highly reactive molecules control fungal growth and development in plants and allow the fungus to elude host defence responses. The research will involve collaboration with researchers at the University of Oxford and Rothamsted Research in the UK. The results of this work will provide fundamental insights into the molecular and cellular mechanisms that control symbiotic fungal growth and development.

Dr Kathryn Stowell and Dr Neil Pollock from Palmerston North Hospital will look at how to control calcium flux in skeletal muscle. This has particular application to malignant hyperthermia, a genetic disorder that leads to complications when patients undergo general anaesthesia. Malignant hyperthermia is caused by mutations in the genes for the proteins that make up 'calcium release' channels in muscles. These channels release the calcium required to trigger normal muscle contractions. Patients with malignant hyperthermia release more calcium than is necessary. In a patient under anaesthesia this can lead to extreme contractions and a rise in body temperature.

Professor David Lambert will investigate whether wingless moa had functional limb genes. Professor Lambert is already well known for having used nuclear DNA sequences from moa bones to determine both the sex of the individuals and the number of moa species. Among his findings: there were fewer moa species than had been thought and in most species the females were substantially larger than the males. The work was published in *Nature* in 2003.

Dr Doug Armstrong will conduct an experimental test of metapopulation theory using reintroductions of a New Zealand bird species, the New Zealand robin. Working with Professor Hugh Possingham from the Ecology Centre at the University of Queensland, Dr Armstrong will remove birds from a soon-to-be logged pine plantation, tag them, and introduce them to a variety of forest fragments which currently lack robins. Over three years, the researchers will measure the robins' predators, food, and patterns of movement between adjacent forest fragments. The research will establish whether remote populations are at greater risk of extinction (as is the established wisdom) and, if so, what factors are responsible.

Professor David Officer will work on artificial photosynthesis with the aim of mimicking light harvesting. Professor Officer has been working on the problems associated with artificial photosynthesis for over a decade and is known for his work with porphyrins, a group of molecules of which chlorophyll is one.

Dr Andrew Sutherland-Smith will investigate how the cytoskeleton regulates cell signalling. Cell motility and migration are fundamental cellular functions for tissue specialisation and growth in higher organisms. Remodelling the cellular scaffold, the cytoskeleton, is central to these capabilities. Dr Sutherland-Smith and his colleagues have found a family of proteins, the filamins, which bind components of the cytoskeleton and participate in tissue and organ formation in a widespread manner in humans. Their studies have also suggested a generalised mechanism for this interaction. Mutations in particular regions seem to change specific functions of filamins – most probably those that enable biochemical communication between and within cells. Some mutations that lead to disease alter the part of the protein that actually binds the cytoskeleton. Others are clustered in defined regions of the elongated portion of the molecule – the rod domain. Dr Sutherland-Smith and his colleagues intend tto study this protein in its normal and mutant forms, focusing on the regions that cause disease when mutated. Exploring the mechanism of function of filamins will have broad implications not only for human disease, but also for cellular biology in general. Professor Stephen Robertson of the University of Otago is the co-Principal Investigator on the grant.

The rise and rise of non-standard work

How standard is standard work? Today, when it is estimated that more than half of those working in New Zealand do so in non-standard jobs, the term, while useful, is a misnomer.

Standardised work has been defined as the "employment of individuals for wages and salaries by a single firm, where [these] individuals work full-time on the employers' premises, and expect (and are expected) to be employed for an indefinite period".

Non-standard work includes such overlapping categories as part-time work, casual work, temporary work, own account work, self-employment, and multiple job holding.

In hindsight it now seems that standard work was 'standard' for just a few anomalous decades during the mid-twentieth century. These decades – principally the '50s and '60s – were a time when the Western world was dominated by systems of mass production known as Fordism (after car manufacturer Henry Ford, who standardised interchangeable parts and assembly-line techniques in his plants, but also substantially lifted his workers' wages to cut employee turnover).

From those mass production lines poured cars, fridges, and other newly affordable consumer goods. In the service of Fordism, workers could expect sustained, stable, and relatively well-paid employment.

These were, to generalise broadly, times when families (many more of them with a stay-at-home mother) had adequate incomes, capitalism was buoyant, and governments had fewer inhibitions about intervening in the workings of the free market or running deficits as an economic stimulus.

New Zealand enjoyed unrestricted access to Britain's market for agricultural goods, and protected its own manufacturing sector with an intricate system of import restrictions and tariffs.

In the early 1970s this all began to change. For one thing, there were the oil shocks and, locally, the impact of Britain's entry into the EEC with the loss of New Zealand's privileged access to the British market. For another, a shift began from mass production towards flexible specialisation.

Locally, the policies of the 1984 Labour Government – labelled Rogernomics after the Minister of Finance – made New Zealand, however briefly, a poster child for deregulation. In Britain the equivalent was Thatcherism; in the US, Reaganomics.

But other larger trends were also under way. A shift was taking place from manufacturing to service economies. Management vogues such as Total Quality Management and Just-In-Time thinned the ranks of middle management, and by taking to subcontracting out work, firms were able to limit their labour costs and became more flexible.

Small firms thrived on outsourced business, while, at the other extreme, multinational corporations and those that dominated particular economies also did – and continue to do – very well.

Governments stepped back from their accustomed roles as regulators and major employers. And technologies impinged on every aspect of our working lives and, with their speed and pervasive reach, hastened the formation of a new global economy.

The standard job is still there of course; it just isn't as dominant. Some commentators see the New Zealand workforce as being split between a highly attached core workforce who experience good to excellent conditions in their employment, and a significant number of peripheral low-attachment employees who lack options and whose conditions of employment – from the rate they are paid to their health and safety provisions – are inferior. Some commentators have taken to corralling jobs into 'good' or 'bad' jobs.

But often a 'bad' job will be linked to a stage in the life cycle – say a tertiary student after enough money to get by on – or a less-well-paid temporary job will be a waystation on the way to a 'good' job. (Although the practice is illegal, it is clear that employers use non-standard work to test potential employees before offering them permanent employment.

Nonetheless, the growth in the proportion of jobs that are casual, part-time and low-paid has major policy implications, particularly if it appears numbers of New Zealanders are being trapped into poorly paid employment and possibly poverty.

If there is a lesson in all of this, it must be that governments cannot effectively address matters to do with social equity by introducing measures that address workers in standard jobs alone.

Paul Spoonley and Carl Davidson

Information excerpted and summarised from *Work & Working in Twenty-first Century New Zealand*, edited by Paul Spoonley, Ann Dupuis and Anne de Bruin, Dunmore Press, 2004.

Ann Dupuis, Anne de Bruin and Paul Spoonley

Ann Dupuis is a senior lecturer in sociology. Her current research focuses on urban housing intensification, women entrepreneurs and non-standard work.

Professor **Ann de Bruin**'s current research areas are labour market issues, including non-standard work; community solutions to unemployment and regional economic development; entrepreneurship, including innovative entrepreneurship concepts; rethinking the welfare state; aspects of the global–local interface; and marketing communications to children.

Professor Paul **Spoonley** has co-authored a number of New Zealand sociology texts. His interests include labour market dynamics and ethnic and cultural diversity. He is a much-sought social commentator.

Profiling the self-employed

In the 2001 census 342,000 New Zealanders described themselves as being self-employed. Of this number 213,117 (62 percent) were self-employed without employees and 129,636 (38 percent) were self-employed with employees.

A fall in the number of self-employed as a proportion of the labour force since 1900 has been followed by an increase since 1980.

Compared to the overall percentage of the self-employed who do not have employees, Pacific Islanders as an ethnic group are over-represented, while Māori and European/Pākehā are under-represented.

Relative to the overall percentage of the self-employed who are self-employed with employees, European/Pākehā as an ethnic group are over-represented, while Pacific Islanders, Māori and Asians are under-represented.

A third category, unpaid workers in family businesses, varies widely among ethnic groups - Māori, Pacific Islanders and Asians being over-represented and European/Pākehā under-represented. This may have much to do with how businesses are run and what is seen as 'family'.

Although there are fewer self-employed women than there are men, self-employment is growing most rapidly among women, with the most significant growth being in the number of self-employed women with employees.

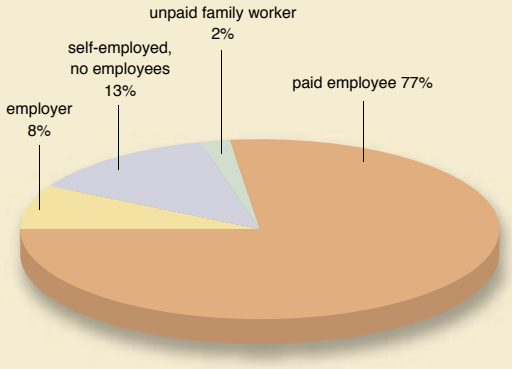
Claire Massey and Kate Lewis

Excerpted and summarised from *Work & Working in Twenty-first Century New Zealand*

Claire Massey

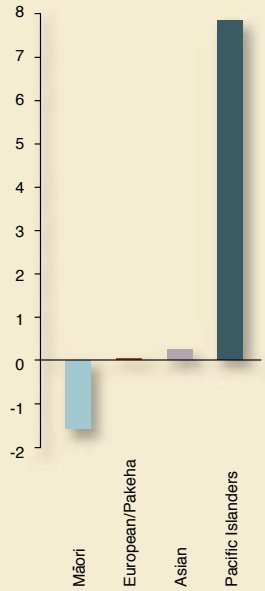
Kate Lewis

Employment in New Zealand, 2001

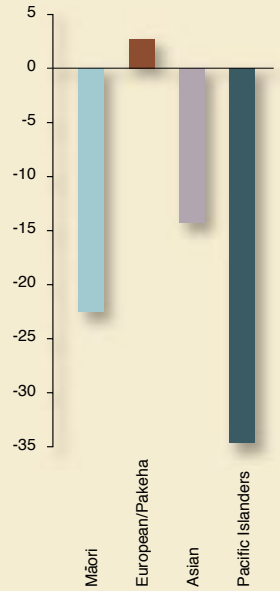


Male and Female Self-employment as a Percentage of the Full-time Labour Force

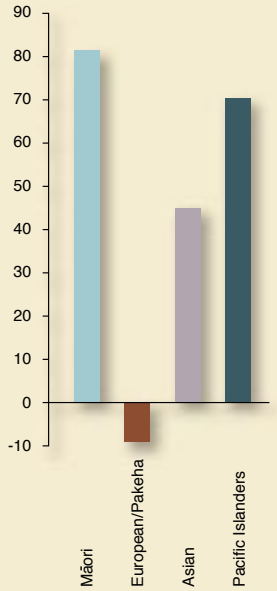
Index of Self-employment by Ethnicity (2001, no Employees)



Index of Self-employment by Ethnicity (2001, with Employees)



Index of Self-employment by Ethnicity (2001, Unpaid Workers in a Family Business)



NB: The indices compare the percentage of a group in a category against the percentage of the total population in that category. A positive index means that an ethnic group has a greater representation than you might expect, all other things being equal; a negative index means that the representation is less than you might expect.

The New Zealand Centre for SME Research

Small to medium enterprises comprise a broad category that includes micro-enterprises (enterprises with fewer than five staff), small enterprises (fewer than 50) and medium enterprises (fewer than 100) in size. In New Zealand these enterprises make up more than 99 percent of businesses and account for about 40 percent of all employment.

The Centre for SME Research was set up in 2000, and Associate Professor Claire Massey is the Centre Director.

One of the Centre's two most recent research contracts is to produce eight case studies examining workplace business practices and illustrating how employers are going about promoting workplace productivity. The work has been commissioned by the Department of Labour and the Workplace Productivity Group, who have signed a similar contract with Deloitte.

The project is being led by Dr Claire Massey, her colleague Dr Martin Perry, and Dr Felicity Lamm of the University of Auckland.

The second research contract has been signed with the Ministry of Economic Development, which has commissioned a study examining the supply of, and demand for, management capability initiatives. This project will be led by Dr Claire Massey, her colleagues Dr Martin Perry and Dr Damian Ruth, and Associate Professor Marie Wilson from the University of Auckland.

Massey's Andrew Gawith and Professor Kerr Inkson will be contributors.

The two contracts are worth $50,000 and $150,000 respectively.

Monitoring Hector's dolphins

Researchers in the University's New Zealand Wildlife Health Centre are analysing information on three Hector's dolphins caught near Banks Peninsula and tagged with satellite transmitters.

Marine mammal expert Dr Padraig Duignan says the preliminary data shows the dolphins were in good health and unstressed by the capture or handling.

From capture to release each dolphin was held for an average of 27 minutes for a health and physiological examination, with its heart-rate and respiration measured throughout. All three dolphins maintained a steady heart rate of around 130 to 140 beats per minute. Dr Duignan says the dolphins are boat-friendly, and this is why they do not need to be chased and their heart-rates did not rise after they were captured and held out of the water.

Blood tests taken to check cell characteristics and determine the health of vital organs also showed low levels of plasma cortisol (a hormone). Cortisol levels are an indication of stress, and the Hector's dolphins' levels were similar to those reported for bottlenose dolphins maintained in captivity, and much lower than those reported for free-living beluga whales captured for blood sampling. The most disturbing finding

for the health screening was that Puari, the oldest female, appears to have been infected by *Brucella*, a bacterium that can cause abortion in dolphins. This could be why reproductive success is so low in Hector's dolphins, and may even explain the rapid decline of Maui's dolphins in the North Island. However, more research is needed on this disease before its impact can be assessed.

Dr Duignan says the steady heart rates and the low plasma cortisol levels suggest that Hector's dolphins may not perceive capture and handling as particularly stressful. This is the first time a health assessment has been done on a living, free-ranging dolphin species in New Zealand and it is an invaluable opportunity to build on the limited bank of information about the mammals.

Since 1996 the Wildlife Health Centre has autopsied 10 Maui's dolphins and more than 60 Hector's dolphins. Dorsal fins from dead dolphins were studied to find the best hydrodynamic design for a satellite transmitter and to find the best way to attach them to the captured dolphins. Both topical anaesthetic and intravenous pain relief were used to minimise discomfort during the process, in which the tags were attached to the dorsal fin using two nylon pins.

Dr Duignan says the dolphins' strongest reaction throughout the tests was to the ultrasound examination, because they could hear the wavelength. Ultrasound is used to measure blubber depth, as a general indicator of the mammals' body condition.

Transmission signals have been monitored from the two female and one male dolphins caught. The first dolphin caught, Puari, was monitored from 4 March until 17 July. The signals provide information on seasonal migrations, the distance travelled during the day, and night-time movements. Puari's signals showed she spent a lot of time outside of the Marine Mammal Sanctuary around Banks Peninsula, originally established to protect the dolphins from fishing vessels and set nets.

Dr Duignan says it is the first time satellite telemetry has been used to assess the daily and seasonal movements of the endangered dolphins, and the information could be crucial to their survival. Satellite telemetry has been used to learn about the movements of New Zealand sealions for several years, and the method is widely used on marine mammals in North America, South America, Europe and Australia.

The research is led by Dr Greg Stone from the New England Aquarium in Boston, who pulled together the team of experts, including Dr Duignan and Gareth Jones from Massey. The Department of Conservation in Akaroa, the Natural Environmental Research Institute in Denmark, the Department of Biological Sciences at Auckland University, and Wellington Zoo are also involved.

The research trial was given full support by Ngai Tahu.

Cancer risk for meat workers

A study of over 6,600 meat industry workers around New Zealand has found a significantly high rate of cancers, particularly lung cancer, which may be caused by exposure to cancer-causing agents carried by animals.

The study, by Dr Dave McLean, Centre for Public Health Research, followed the health status of 6,647 people who work or have worked in the meat-processing industry from three plants in New Zealand. International research indicates there is an increased risk of cancers of the lung and larynx, and of leukaemia and lymphoma, among butchers and slaughterhouse workers. Dr McLean set out to see whether the same was true for New Zealand and to identify the exposures associated with any increased risks.

The study found the rate of lung cancer in the group significantly higher than in the general population. Dr McLean says while it is possible that smoking and the ethnicity of the workers had an impact on these findings, it is highly unlikely that either factor is sufficient to account for more than a small part of the excess observed.

"There are two key findings that are of considerable interest. The first is that there is an excess of lung cancer, for which there is a strong dose-response relationship based on how long people had worked in certain jobs. Lung cancer was most strongly associated with exposures to biological material in animal urine, faeces or blood. We don't know what the cause is, but one possibility is that they are exposed to a biological element, caused by something like a bacterium, virus or fungus, which is carried by the animals.

"The second finding is that despite small numbers there is evidence of an association of cancers of the lymphohaematopoietic system with how long people had worked in meat-processing and plant services. This was particularly associated with exposure to animal faeces. This effect appears to exist for non-Hodgkin's lymphoma, and possibly also for leukaemia."

Dr McLean says that while there has been very little research into the types of exposures that occur in the meat industry, potentially hazardous exposures are primarily biological, including bacterial and viral infectious agents as well as non-infectious bioaerosols. There is also a limited range of potential exposures from chemicals either used in the process or in the maintenance of plant and equipment, or encountered as residues of animal remedies or pesticides used on farms.

Dr McLean emphasises that there is no evidence to implicate the meat processed in the plants, or to indicate any risk to consumers.

"Evidence would appear to suggest that the risk is associated somehow with the handling of live animals and the slaughter process itself, and high exposures to that process, and that it disappears completely in those jobs that involve the further handling of meat, such as the meat cutters or retail butchers. But further research is required before we could positively identify the causes."

He says the findings could have significance for public health policy-making because of the number of people employed in the meat-processing industry in New Zealand. However, further research is required to identify the specific agents responsible, so preventive measures can be developed.

The study found that mortality from all causes was higher than expected based on the general population (227 deaths compared with 204 expected), and from all cancers (69 deaths compared with 61 expected). Among the cancers, significant excess mortality was observed for lung cancer (23 deaths compared with 13 expected).

Of the 6,647 people studied, the majority had been employed on the slaughter board (44 percent) or in meat cutting (28 percent), with a further 10 percent employed in departments associated with the processing of edible and inedible offal and meat wastes.

Dr McLean worked with Soo Cheng and Professor Neil Pearce, from the Public Health Research Centre; Andrea 't Mannetje, from the International Agency for Research on Cancer (a branch of WHO); and Alistair Woodward, Wellington School of Medicine, on the project, which was funded by the Health Research Council.

Photo courtesy of Commercial Vehicle Investigation Unit

Risk and the tired truck driver

Driver fatigue is a factor in as many as one in six truck crashes. The finding comes from a 13-month study of driver fatigue in truck crashes conducted by the Sleep/Wake Research Centre, funded by the Road Safety Trust. The incidence is more than three times higher than earlier estimates based on Land Transport Safety Authority (LTSA) crash reports.

During the study 380 questionnaires were distributed by Commercial Vehicle Investigation Unit (CVIU) officers to drivers involved in truck crashes in 2001–2002. 146 of the drivers completed questionnaires. These were then matched to crash reports from the LTSA crash database.

Crashes were compared for severity; type of vehicle, service or load; time of day when crashes occurred; age of the drivers; hours driven or hours on duty at the time of the crash; and hours driven or hours on duty since the last 24-hour break.

Driver fatigue was identified in three ways: first, by the CVIU officers ticking a box on the crash report form when they thought driver fatigue was a factor in the crash; second, by drivers themselves ticking a box on the questionnaire to indicate that they thought their own fatigue was a factor in the crash; third, by analysing each driver's recent sleep and duty history, to see if they were likely to have been affected by the biological risk factors for fatigue.

The crashes where the CVIU officer had identified driver fatigue featured long driving hours, long duty hours, or had happened at particular times of the day. Crashes where the driver had driven for at least six hours were about three times more likely to be identified as fatigue-related; crashes where the driver had been on duty for at least seven hours were about three times more likely to be identified as fatigue-related; and crashes between midnight and 8.00 a.m. were eight times more likely to be identified as fatigue-related. A total of 8.5 percent of crashes occurred between midnight and 8.00 a.m. and involved long duty hours, or long driving hours, or both.

Of the drivers, six identified their own fatigue as a factor in their crash, and a further three answered "maybe". In total, this represents 6 percent of the drivers who answered the question. A further five drivers considered the other driver involved in their crash was fatigued, though they themselves were not.

In analysing each driver's recent sleep and duty history, four definitions of biological risk factors for fatigue were used:

- extended wakefulness – being awake for longer than 12 hours at the time of the crash
- acute sleep loss – having less than six hours sleep in the 24 hours prior to the crash
- cumulative sleep debt – at least a week since the driver had two nights of good sleep in a row
- time of day – crashing between midnight and 8.00 a.m.

In total, 11 percent of drivers had at least two biological risk factors for fatigue at the time of the crash.

There was little agreement between the three methods for identifying driver fatigue. On the one hand, the CVIU officers and drivers had much more information about each crash than did the Sleep/Wake Research Centre, but they were probably not aware of the biological risk factors in most cases. On the other hand, there may have been crashes where the truck driver's actions played no role, despite his/her having at least two biological risk factors for fatigue.

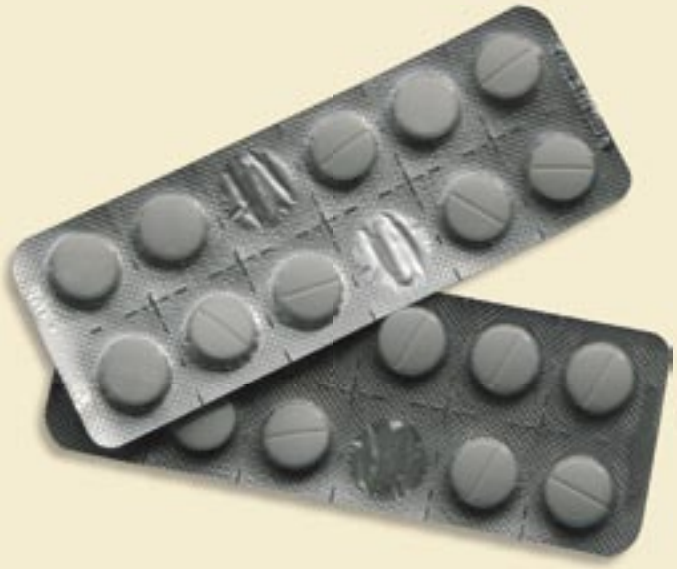
Of the crashes, 17.6 percent were identified (by at least one of the methods) as involving driver fatigue. This is 3.5 times higher than indicated by the LTSA crash reports for the study period.

The Director of the Sleep/Wake Research Centre, Professor Philippa Gander, says she has recommended that the LTSA take the lead in a major campaign to educate truck drivers and the general public about the dangers of driving when sleepy.

"In the United States, driver fatigue is recognised as the number one safety issue in the trucking industry," says Professor Gander. "You don't have to be nodding off to be at risk," she says. "When you are fatigued your reaction times slow, you don't steer as well, your speed control deteriorates and your cognitive functioning is impaired. This means that your ability to assess a situation and react to it decreases."

The Director of the Sleep/Wake Research Centre, Professor Philippa Gander

Paracetamol or antibiotic use early in life may increase the subsequent risk of asthma



Children who were given paracetamol early in life have a higher risk of having asthma symptoms now (about 25 percent) compared with children who were not given paracetamol early in life (about 15 percent).

Children who had used antibiotics early in life also had a higher risk of having current asthma symptoms (about 28 percent) compared with children who had not used antibiotics early in life (about 16 percent).

These are two of the key findings from a survey conducted by the University's Centre for Public Health Research and the Institute of Environmental Science and Research (ESR), which has just been published in the *Journal of Epidemiology and Community Health*.

The survey was designed to learn more about childhood infections and asthma risk. The study surveyed parents of 1,584 children who had been notified to public health services with serious infections at age 0–4 years. It compared their health with 2,539 children sampled from the general population.

For the children in the survey, about 24 percent currently had some asthma symptoms – about the same as in the general population, so having an infection early in life didn't seem to have affected their risk of getting asthma.

Having a cat early in life did not increase the risk of getting asthma or hay fever. In fact, it actually reduced it a little.

Professor Neil Pearce says these findings should be regarded as preliminary, and there are no immediate policy implications.

"It's not clear yet as to what is causing what. Are parents giving their children antibiotics or paracetamol for infections, and is it the infections themselves that increase the risk of asthma? Are parents of asthmatic children more likely to remember what medicines they took early in life?

"However, if these findings are confirmed in further research then they would indicate the need for greater caution in the use of both antibiotics and paracetamol early in life.

"We would like to stress that these findings don't mean that parents should stop giving their children antibiotics or paracetamol when it is appropriate to do so. Furthermore, the increase in asthma risk, if it is real, is quite small and there is no need to be concerned if your child took antibiotics or paracetamol early in life.

"The findings are consistent with what has been found in several overseas studies. It will help us in our continuing research to try and find out what causes asthma, and how we can prevent it."

Illegal drug trade value doubles in decade

The illicit trade in amphetamine type stimulants may have effectively doubled the dollar value of New Zealand's total illegal drug trade in less than 10 years, a study conducted by researchers at the Centre for Social and Health Outcomes Research Evaluation (SHORE) has shown.

Commissioned by the Police, the study on the socio-economic impact of ATS was led by Dr Chris Wilkins and carried out in collaboration with the Office of the Police Commissioner.

The research included a survey of frequent methamphetamine users in Auckland, key informant surveys of drug enforcement officers and drug treatment workers, an analysis of drug treatment statistics, and a pilot study of arrestees in the Papakura Police Station cellblocks.

Dr Wilkins and his team were unusual in surveying ATS users rather than speaking to those undergoing treatment. The interviewees were recruited with flyers in cafés, bars, needle exchanges and public places and interviewed in Auckland cafés.

Dr Wilkins estimates the value of the illicit market for amphetamine, methamphetamine and MDMA/Ecstasy in New Zealand at $168 million dollars a year, or close to that of cannabis. About one in ten New Zealanders aged 18 to 29 – or about 100,000 people nationwide – have used an ATS drug in the last year and about a third of these are frequent users. This group appears to have a more middle-class profile than that of other drug users; many users are well educated and employed in well-paid jobs.

Many of the frequent users of methamphetamine reported pre-existing mental health problems and tendencies to self-harm. They said methamphetamine exacerbated these problems.

The pilot study of arrestees showed they were far more likely to use these drugs than the general population. They said that these drug types were a factor in their criminal offending and made them more likely to get angry.

Frequent methamphetamine users were often involved in dealing and drug manufacture. A third had sold methamphetamine and about one in five had made it or exchanged it for stolen property.

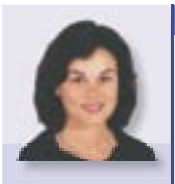
About half of amphetamine buyers make their deal by mobile phone or by texting. The sellers surveyed reported only selling to close friends and family members.

Key informants indicated high levels of involvement by organised criminal groups in importing, making and selling methamphetamine. Long-established gangs and their role were commonly mentioned.

The research was carried out with the oversight of the University Ethics Committee. The participants were assured of confidentiality and the data was subjected to a process that makes it impossible to identify any particular participant. The Police Commissioner's Office gave an undertaking that officers would not follow the interviewers or use the meetings for any undercover operation. The interviewers, were trained in self-defence, worked in pairs, and had a back-up arrangement in place with police should any situation become unsafe.

If Dr Wilkins is correct, then the value of drug seizures amounts to around 10 percent of the market. However, the study shows some evidence that law enforcement is beginning to make an impact. Sixty percent of regular methamphetamine users indicated they had noticed more law enforcement activity against methamphetamine offending in the last six months. About one-third reported that more of the users they knew had been arrested for methamphetamine offences over this time and 10 percent reported it was more difficult to obtain methamphetamine than six months ago.

Fast Start Funding Recipients 2004



Dr Catherine McCartin: Online model theory and online algorithms

Suppose that you are directing the packing of three trucks with crates of varying dimensions, and you want to pack them as efficiently as possible, but there's a catch: you are only given the crates one at a time. You must make a decision about what to do with each crate as soon as you receive it, but you have no certain knowledge of the dimensions of the crates that you haven't seen yet.

Many situations occur where decisions have to be made about things where only some of the background information is available, and nothing is known of the events that will occur in the future. In computer science these situations are called 'online problems'. Online problems occur everywhere, from the investment of sharemarket funds, to the operation of robotic machines like the Mars Rover.

Dr McCartin will carry out two related projects. First, although online problems are common, virtually no techniques currently exist for mathematically analysing them. Dr McCartin will develop a systematic mathematical framework for online problems, working with Professor Rod Downey from Victoria University of Wellington.

Second, Dr McCartin will aim to use the theory from the first part of the project to develop practical methods for the operation of 'reactive sensor networks'. Reactive sensor networks are networks of sensors that can perceive and respond to their environment, by repositioning themselves to acquire and deliver information in the best possible way. This work will be done jointly with robotics expert Professor Daniela Rus from Massachusetts Institute of Technology.

Dr Ulrich Zuelicke: Spintronics without magnets: A new road to nanodevices and quantum information processing

Information has become the single most important commodity in almost all aspects of our daily life. The capacity to process ever larger amounts of data ever more rapidly has so far come from the technological possibility to reduce the size of electronic device elements in integrated circuits exponentially with time. As transistor features on present chips reach lengths of only a few dozen nanometers, fundamental properties of the microscopic world are creating obstacles to further miniaturisation. Instead of giving up, however, scientists are turning the nanoscale barrier into the gate to a new electronics frontier. As part of this effort, Dr Zuelicke is pursuing alternative ways for doing electronics. Present electronic devices are only sensitive to the charge of electrons. He is investigating how current flow could instead be manipulated using the electron's flavour degree of freedom, which is called spin. Most current proposals for spin(-elec)tronics devices involve magnets, as the spin of the electron interacts with magnetic fields. Dr Zuelicke is developing an entirely new approach, advocating a magnet-less spintronics paradigm. His concept is based on the interplay between the wave nature of electrons in nanostructures and their spin in new types of electron interferometers.

Dr Justin O'Sullivan: Do DNA loops actively regulate rDNA synthesis?

DNA looping can control gene expression by excluding or enhancing interactions between transcription factors and a gene's promoter. It is proposed that a DNA loop forms within the rDNA locus and is responsible for maintaining high rates of rRNA transcription. This would extend recent observations that identified promoter-terminator interactions at two RNA Polymerase II transcribed genes. Furthermore, demonstrating the existence of a DNA loop at the rRNA locus, while increasing the understanding of transcription per se, would also link DNA topology with a number of cellular processes, including ageing.

Dr Stephen Marsland: A principled approach to the non-rigid registration and structural analysis of groups of medical images

Medical images such as magnetic resonance images provide information about the internal structures of the human body. These images can help diagnose disease. The problem is that even in healthy individuals biological structures – such as regions of the brain, for example – can vary widely from person to person, making it difficult to reliably detect what is disease and what is not. Complicating the matter, the appearance of disease on the images can also vary among individuals. Dr Marsland's project will use mathematical functions known as diffeomorphisms to warp images taken from different people so that they look the same, and then analyse the functions that were used in order to recognise different diseases.

Dr Elizabeth Gray: Transfigurations: Christian and lyric tradition in Victorian women's poetry.

Because it does not voice feminist protest, much of the Victorian literature that promoted Christian ideals of womanhood has been neglected by recent literary studies. This has meant that our understanding of nineteenth-century literature and society has been quite one-sided. Dr Gray's project will explore the ways Christian religion offered Victorian women poets unexpected kinds of liberty, influencing the development of poetry and the development of women's ideas about themselves and their society.

Fast Start grants, which are worth $50,000 a year for two years, are awarded as part of the Marsden Fund, which is administered by the Royal Society of New Zealand.

Fast Start Funding Recipients 2003

Dr Chris Wilkins: Illicit drugs and organised crime

Dr Wilkins, from the SHORE Centre in Auckland, is studying the level of organised crime in different illicit drug markets in New Zealand to try to determine which illicit drug markets nurture the development of organised crime.

"Most criminal activity is undertaken by individuals and is not conducive to large hierarchical organisations, which are vulnerable to law enforcement. However, it appears some types of criminal activity require greater organisation and hence assist in the development of organised criminal groups. For example, alcohol prohibition assisted in the growth of the mafia in the United States during the 1920s. One of the hypotheses that will be investigated in this research is whether the domestic production of methamphetamine is playing a similar role in New Zealand."

The project has direct applications for law enforcement in relation to different illicit markets. If the project suggests methamphetamine production and trafficking is nurturing greater criminal organisation, then that is one more reason to devote more law enforcement resources to that problem, he says. Dr Wilkins is collaborating with leading international researcher in organised crime and economics Professor Peter Reuter from the University of Maryland, and SHORE Centre director Professor Sally Casswell.

Dr Adriane Rini: Aristotle's Realm of Darkness

Dr Adriane Rini from the School of History, Philosophy and Politics is working to bridge an ancient gap in the understanding of Aristotle's science. New Zealand logicians are famous for a specialised branch of 'modal logic'. Dr Rini will apply modal logic to a misunderstood area of Aristotle's logic, known as 'Aristotle's Realm of Darkness'. Dr Rini says this misunderstanding has arisen largely from a lack of communication and shared knowledge between two disciplines – those who study logic, and those who study ancient Greece. Modal logic focuses on necessity and possibility – precisely the parts of Aristotle's theory that remain unexplained.

Dr Chris Stephens: Investigating social capital

Dr Chris Stephens of the School of Psychology, is investigating some of the ramifications of the concept of social capital. The project, *Social Capital: How does social connectedness work to benefit all*, will focus on New Zealand community groups. Social capital can be seen to operate in the form of voluntary groups and organisations, social groups and, more intangibly, in measures such as the trust people place in one another, and their sense of belonging.

Dr Christine Cheyne: Participation in local government

Dr Christine Cheyne of the School of Sociology, Social Policy and Social Work is examining how people interact with local government, particularly focusing on the issue of non-participation. Some groups, such as young people and Māori, are less likely to participate in local government. Dr Cheyne intends to identify why this is, and to suggest how more people can be persuaded to participate. She also intends to suggest ways in which the information available about local government and its operations can be improved.

"Policy and legislative changes at central government level are placing greater responsibility on local government, making it even more important for people to understand the role of local government and to participate in the process," she says.

Dr Carlo Laing: Modelling neural networks

Dr Carlo Laing of the Institute of Information and Mathematical Sciences is mathematically modelling neural networks. The human brain consists of around 100 billion neurons connected in a network of almost unbelievable complexity. In certain situations, large groups of these neurons behave in a coherent fashion, firing at the same time and forming spatial patterns in the brain. Cases in point are when someone tries to remember something for a brief period (such as a phone number before writing it down), tries to make a decision, or has an epileptic seizure.

These patterns can be modelled mathematically. Back in the 1970s sets of partial integro-differential equations were proposed to model large-scale patterns of activity in the brain, and since then models have been used to understand some of the images seen during hallucinations, to model short-term memory, and to understand decision-making in infants.

Because the mathematics is highly complex and, until recently, computer power was limited, the models commonly assumed that the brain can be represented by one long string of neurons. But the brain is better represented as a two dimensional sheet – as Dr Laing is choosing to do – rather than a one-dimensional line. Dr Laing is using his own techniques to transform the various partial integro-differential equations into partial differential equations, about which much more is known. Some of the phenomena he will attempt to model – such as spiral waves – cannot occur in one-dimensional systems.

His work will result in more realistic neural models which can be related directly to phenomena such as short-term memory, decision-making in infants and pathological brain states such as epilepsy.

He will run the models on Massey's supercomputer cluster, Double Helix, using software he has written.

Dr Fu-Gunag Cao: Exploring nucleons

Nucleons – the protons and neutrons of the atomic nucleus – are among the most common particles found in nature. While nucleons are known to be made of point-like particles called quarks, how the quarks conspire to produce the nucleon still eludes physicists. Dr Fu-Gunag Cao, Institute of Fundamental Sciences, is trying to solve some of the mysteries by studying the spin structure and the 'flavour' structure (the types of quarks) of the nucleons. Dr Cao is one of New Zealand's few experts in this field.

Dr Antonia Lyons: Gender and alcohol consumption

Dr Antonia Lyons of the School of Psychology is investigating gender and the consumption of alcohol, focusing on the ways in which women and men are changing in terms of societal definitions of masculinity and femininity. Her research may help explain why alcohol consumption is on the rise, especially among young women. Dr Lyons will work with men and women between the ages of 18 and 29.

Dr Richard Shaw: Straightening the spin

Dr Richard Shaw of the School of Sociology, Social Policy and Social Work is examining that phenomenon of recent years, the political adviser. The trend towards coalition and minority governments under MMP has made the business of forming and maintaining governments more complex than it once was. The management of political relationships within coalitions, and between minority governments and parliamentary support parties, cannot be done by public servants. Increasingly, that task is falling to partisan advisers appointed by ministers. But the adviser's role may be having an effect on the traditional relationship between ministers and senior public servants.

Dr Shaw intends to establish what effect, if any, the advent of political advisers has had on decision-making within the political executive.

Fast Start grants, which are worth $50,000 a year for two years, are awarded as part of the Marsden Fund, which is administered by the Royal Society of New Zealand.

Top Achiever Doctoral Scholars 2004

Sandra Brown, a senior research fellow at the SHORE Centre in Auckland, is to find the most effective evaluation method for providing development assistance and for monitoring and measuring outcomes in Māori community development. The aim is to identify the best way to evaluate whether the increasing number of development programmes being implemented by iwi and other Māori groups are effective, and which are most successful.

Judith Engelbrecht, from the Institute of Information Sciences and Technology, is developing a model to determine how information systems can be used to enhance decision-making in primary health care, in particular in relation to the new primary health organisation environment.

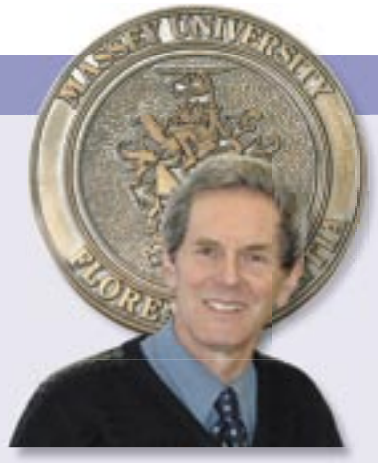
Barbara Plester, from the Department of Management and International Business, is undertaking a study to establish the relationship between the use of humour and the prevailing organisational culture inside a variety of New Zealand organisations. The research will also attempt to uncover actual organisational outcomes that arise from the use or misuse of humour at work.

Raewyn Poulsen, Institute of Food, Nutrition and Human Health, is investigating the potential of bone-active nutritional factors as an alternative to hormone or oestrogen replacement therapy to prevent osteoporosis in post-menopausal women.

Benedict Van Hooijdonk, Institute of Natural Resources, is to try to understand the phenomenon of dwarfing rootstocks used in New Zealand's apple industry. It is hoped the study will determine a critical stage of development when the architectural traits of dwarfing are first expressed and the hormonal basis for this, with the aim of developing genetic markers and architectural models that improve the effectiveness of rootstock production.

Government-funded Top Achiever Doctoral Scholarships provide PhD students with $25,000 a year plus $3,000 per year for conference travel and fees.

Outstanding Individual Researcher



Within the Institute of Fundamental Sciences, Professor David Parry is regarded as an inspiring leader, teacher and administrator who has led the turnaround in fortunes of the fundamental disciplines (chemistry, mathematics and physics), with student enrolments increasing in each of the past three years.

But internationally the inaugural winner of the Individual Massey University Research Medal is better known as a world authority on fibrous proteins: the proteins that make up muscles, connective tissues, hair and skin.

His discovery that hair undergoes a major structural transformation between its formation in the hair follicle and when it emerges from the scalp enabled those working in the biomedical field to better understand hair and, more surprisingly, skin diseases at the molecular level.

His work has also involved studying the various mutations that occur in diseased skin. In identifying these he has shown that it is often possible to work out why the mutations have the effect they do. "Of course, that's just the first step in the process of finding a suitable treatment," he says.

Professor Parry's work on skin, cornea and other connective tissues has had direct medical implications. For example, some years ago he worked with an Auckland plastic surgeon and, as a result of their work, the surgeon was able to modify his surgical techniques to reduce scarring.

Associate Professor Dean Halford, the Institute's Deputy Head, says one of the most highly recognised contributions Professor Parry has made is his formulation of the steric blocking mechanism for the regulation of vertebrate skeletal muscle. His discovery some 30 years ago of the mechanisms through which muscles contract and relax led to commercial applications in the meat industry with the introduction of electrical stimulation to meat carcasses to maintain tenderness.

Dr Halford says Professor Parry has also made significant contributions to the field of fibrous proteins by studying the relationship between the amino acid sequence of a protein and its function. This has led to an enhanced understanding of the structure–function relationship in a wide variety of other fibrous proteins.

On a recent Marsden-funded project he has worked with colleagues from two biomedical research groups in the United States on a radical new model for the structure of coiled-coil molecules. They believe that proteins are far more dynamic and flexible than previously thought, thus allowing them to interact with other components in the cell in ways not previously imagined.

Professor Parry says their theory is yet to be proved, but there is promising evidence that this is the case. "If we are found to be correct, it will change our understanding of how hair, skin and muscles work. It will also open up new possibilities of designing functional proteins."

Professor Parry's standing in the international science community was recognised in 2002 when he was elected Vice-President of the International Council for Science (ICSU) – the first New Zealander to be appointed to this position. As such, he has a senior leadership role on the international executive that represents about five million scientists from 27 unions and 103 countries worldwide. He also chairs the Committee on Scientific Planning and Review (ICSU).

"It's a very exciting opportunity. ICSU is *the* international body as far as science administration goes. It's the equivalent of the United Nations in politics or the World Trade Organisation in trade. I've been excited to have the chance of influencing where world science goes over the past two years. There is plenty more to do too before our General Assembly in China next year."

During his term of office Professor Parry's specific duties have included convening a committee on strategic policy, which will determine much of the policy that the international science community will follow.

It was a case of 'who he knows not what he knows' that led to Professor Parry presenting a series of lectures across the country last year. To celebrate the 50th anniversary of the discovery of the structure of DNA, the Royal Society of New Zealand hosted a lecture series on the life and times of New Zealander Maurice Wilkins, whose research was instrumental in the breakthrough. Professor Parry was a PhD student under Professor Wilkins at Kings College in London from 1963 to 1966.

After completing his PhD, Professor Parry spent three years in Melbourne at the CSIRO Division of Protein Chemistry, before moving to the Children's Cancer Research Foundation in Boston in 1969. His work there involved an association with the Children's Hospital and the Harvard Biophysics Department. Two years at Oxford followed, before Professor Parry came to Massey University in 1973. He was awarded a personal chair in Biophysics in 1985 and became head of the Institute of Fundamental Sciences in 1998.

Professor Parry has 184 publications in international refereed journals, has been cited more than 5,200 times in research papers since 1980, and has delivered 40 invited or plenary addresses to international conferences. He has written or edited various books on his area of expertise – fibrous protein structure and function – and is currently on the editorial board of the *Journal of Structural Biology* and the International *Journal of Biological Macromolecules*.

His research has been recognised nationally and internationally. He was awarded the Sir Charles Hercus Medal from the Royal Society of New Zealand in 2000, the ICI prize for Outstanding Achievement in Chemical Research in 1981, and a DSc from the University of London in 1982. He is a Fellow of the Royal Society of New Zealand, of the New Zealand Institutes of Chemistry and of Physics, and of the United Kingdom Institute of Physics. For 12 years he served on the Council of the International Union of Pure and Applied Biophysics, with three years as President. Professor Parry has also served on the NZVCC Scholarships Committee for 17 years, the last eight as Convenor.

Early Career

Dr Ulrich Zuelicke, from the Institute of Fundamental Sciences, is fascinated by the theory of functional nanostructures. He is currently researching the interplay between quantum effects, such as tunnelling and wave-like behaviour, and their effect on ultra-small transistors and wires in determining electronic and transport properties in nanostructures.

Professor David Parry describes Dr Zuelicke as one of the most brilliant young scientists he has met. "He is clearly in a league of his own and I have an absolute conviction that he will reach the top of his field in a very short period of time."

Dr Zuelicke, who won a Fast Start grant in 2004, already has 36 publications in international refereed journals. He has presented 12 invited or plenary addresses to international conferences and presented 30 seminar talks in the past six years.

He won the Outstanding Graduate Student in Research Award from Indiana University in the United States in 1997 for the quality of his PhD research thesis.

Early Career

Dr Jeroen Douwes has been with the Centre for Public Health Research since gaining his doctorate in 1998 and was recently appointed Associate Director. He leads the asthma research programme, investigating non-allergic mechanisms for asthma, the role of microbial exposures, asthma in farming families and the potential protective effects of exposure to endotoxins, as well as being a co-investigator in international studies.

Centre Director Professor Neil Pearce says Dr Douwes has played a leading role in re-orienting and refocusing asthma research internationally away from a previous over-emphasis on allergens towards non-allergic mechanisms.

Dr Douwes has been invited to speak at numerous international conferences and is a contributor to leading journals in his field. He was recently awarded the Sir Charles Hercus Fellowship from the Health Research Council – the first time it has been awarded to a public health researcher.

See page 26 for more about Dr Douwes's work on asthma.

Research Team

The Allan Wilson Centre for Molecular Ecology and Evolution has been awarded the 2004 medal for a research team. The Massey members of the CoRE (Centre of Research Excellence), hosted by the Institute of Fundamental Sciences and Institute of Molecular Biosciences, are Centre co-directors Professors Mike Hendy and David Penny, Professor David Lambert, and Associate Professor Peter Lockhart. The Massey staff will share a research grant of $25,000,

Set up with $17 million in government funding after a competitive bidding process, the Centre has grown to 74 workers, including seven principal investigators, three associate investigators, 16 postdoctoral fellows, 14 technical staff, 18 PhD students, seven MSc students, five RSNZ teaching fellows and four clerical staff.

The Centre's assets include DNA sequenators and the world-class parallel supercomputer, Helix (currently being upgraded).

Professor Robert Anderson, the Pro Vice-Chancellor of the College of Sciences, describes the development of the research programme under the leadership exhibited by Professors Hendy and Penny as spectacular.

See page 48 for more about Professor David Lambert of the Allan Wilson Centre.

Supervisor

Associate Professor Kerry Chamberlain from the School of Psychology, on the Albany campus, has been awarded the Supervisor Research Medal and $10,000. Dr Chamberlain is actively involved in graduate supervision, having supervised 14 PhD and more than 60 master's and honours' students.

His principal teaching and research interests are health psychology and research methods.

He is particularly interested in food, diet and health, the marketing of medication, socio-economic factors in health and illness, and the media representations of health and illness.

Former students of Dr Chamberlain describe him as able to combine constructive criticism with a respect for the work and opinions of others, and as a teacher who unfailingly challenges his students to extend themselves.

See page 54 for more about Dr Chamberlain.

Hodgson's thoughts

MASSEY RESEARCH puts Pete Hodgson, Minister of Research and Development, to question.

When Pete Hodgson was a veterinary student his classmates and lecturers regarded him as straight-forward, quick thinking, and possessed of a keen sense of humour. Thirty years after his graduation with a degree in veterinary science, his friends, colleagues and constituents say the description still fits. He is regarded as an informed, able and accessible Minister of Research, Science and Technology, Energy, Fisheries, Forestry and Crown Research Institutes.

Born and raised in Whangarei, Pete Hodgson practised as a vet in Canterbury in the early 1970s and in England in the early 1980s. He has also worked as a high school science and mathematics teacher and manager of a range of small businesses.

His involvement in politics began in the late 1980s, when he was employed by the Labour Party as a marginal seats organiser. He has been the MP for Dunedin North since 1990.

What do you remember of your time at Massey?

Well, they were my formative years of course and so I remember them very warmly indeed, and many of my friends in life are friends I made here. The veterinary degree was a very exacting degree and had a high attrition rate and so we kind of knew that we had to knuckle down to get through. I missed a year, unfortunately. It was because of too many parties in Burke Street and deciding to jump goods trains between finals, which was not a good idea. That aside, I have very fond memories of Massey indeed and come back here often.

How is it you came to politics?

I don't know. I don't know why a person would go from veterinary science into politics, but I think politics is in my blood and it just is in some people's blood. I gave up veterinary science and worked for the Labour Party, for goodness sake. This is a serious case of having politics in your blood.

Yours is a political family?

No, it's not. It's not. My wife's apolitical, my children are apolitical, my parents are barely political. If I reach back far enough I can find a grandfather but he was involved in a thing called the Country Party and only for about six months, so I don't think that counts either. No it's not a political family. It's really interesting. I don't know where it came from. I mean, I am highly political.

As Minister of Science and Technology, you are known to be a strong advocate for research and development. Nonetheless, given our relativities with other nations, is the Government doing enough to support, and acknowledge our best researchers and retain them in New Zealand?

Well, how long can you give me to answer? We've increased science funding nominally by around 42 percent over the last five budgets. In real terms, taking out inflation, that's 32 percent. So that's quite a chunky increase. One of the features of the New Zealand innovation system is that it's dominated by the public sector. So whereas our investment in science is just slightly below the Western world average – 10 percent below where it should be probably – private sector investment in R and D is around about a third of the Western world average. So we've got a very unusual mix between public and private sector that is both a symptom and a cause of our stage of economic development.

In what way?

On the one hand it's a symptom in that New Zealand is a very high-quality agricultural primary production nation – and primary production research tends to be a small part of industry turnover in the agricultural sector – smaller than, say, research towards building aeroplanes or making drugs. But the agricultural research that we do produce is amongst the world's best. That's why our economy is so strong in agriculture. It's a symptom of our stage of economic development because there's more primary production going on here than in any other Western nation and less of the manufacturing or so-called high-tech sectors.

. . . whereas our investment in science is just slightly below the Western average – private sector investment in R and D is around about a third of the Western world average.

And then it's a cause of our economic development because our attachment to commodities, no matter how good we are at it, has meant that our standard of living has dropped relatively over my lifetime. I was born into the third richest country in the world. I currently live in the 21st richest country in the world, and our attachment to agriculture has been part of that change. So the Government's primary focus has to be to ensure an increase in private sector involvement in R and D through a thousand different ways. And we have made some progress on that.

What should we be doing to support and retain our best researchers?

One answer is to increase the demand for research by increasing private sector investment in research. That's a really boring answer. It's not one that people would immediately come to but it's the one that's at the top of my mind. And then the other way is simply to increase available funding on the public sector side, giving it the attention that we've put into excellence with the Centres of Research Excellence. There's also the work that we've done with the scholarships, the post-docs and things that have just rolled out over the years, including the celebration of young New Zealand scientists. One example is the Foundation for Research, Science and Technology award dinner in Auckland in July.

Where do you think companies should be conducting their own research or commissioning it out? Should Fonterra, for example, be doing its own research or relying on AgResearch?

Answer to that specific question? Both. Fonterra – we were there yesterday – is the largest private sector investor in New Zealand. Of course they should be doing some of their own research. They have a long history of it, starting with the Dairy Research Institute – which now goes by the name of Fonterra Marketing and Innovation, you'll be pleased to know. On relying on AgResearch? Well, the dairy research/AgResearch linkages have been insufficiently strong in New Zealand – it's been a matter of some distress to me actually. But recently, quite recently, they have improved significantly and so now it can be both. Let's make sure we don't try to put black/white questions around science because you very rarely get black/white answers.

If you were an international biotechnology company or investor, how do you think you would view New Zealand as a place to do business?

I would say: It is very, very far away and it is very unknown, therefore it's a hard place to do business. However, as I got here, and given that I have only just arrived and been here a month, I'm surprised by two things. First of all I'm surprised by the quality of New Zealand science. I'm very impressed by the quality of New Zealand science and the range of that science, especially related to technology and in all of the applied biologies. And I find it all undervalued, which delights me a lot. This is an inefficient market. Now that I've arrived here I'm probably going to be able to get hold of intellectual property cheaper than if I were trying to get hold of it in San Diego. So – you know, the plane flights are a real problem – but I'm coming back.

Many scientists believe the HAZNO [the Hazardous Substances and New Organisms Act] and ERMA [the Enviromental Risk Management Authority] processes are onerous and may be stifling innovation or changing the nature of research that is done. Do you think legislation strikes the right balance between providing environmental protection and allowing innovation?

I think probably there will be instances where our decision to run the most transparent, precautionary and participatory regulatory system that I know of has stifled innovation or changed the nature of the research that's being done. I think that is true and I think that all around the world biotechnologies are doing that to societies. It's relevant that we are now seeing an amazing debate going on over stem-cell research. For example, the southern states of the USA don't like it. The northern and western states don't seem to mind it. Go to Australia and you also find a mix but geographically the other way round. They've embraced stem-cell research in Victoria much more than they have in Queensland. Then there's xenotransplantation which is causing nervousness in some places but not in others. Prince Charles has decided to get himself distressed about nanotechnology, now that he's learnt how to spell it, and so on. You end up with a variety of societal reactions to technologies. The New Zealand reaction to nuclear technology is a very good example. I'm not in the least bit critical of and entirely supportive of (I should say in brackets – in case there's any doubt) the anti-nuclear argument. But one thing I'd like to say about this is that generally speaking the first round of genetic engineering is of not much use to New Zealand. All of the technologies about Round-Up Ready soy or Round-Up Ready cotton or Round-Up Ready maize or Round-Up Ready, call it what you like really, are fine. We don't grow soy or cotton in this country. We do grow some maize but we don't grow much. But there's a bunch of technologies, GE technologies, that could be wildly useful in New Zealand, in producing energy out in the environment. What the antagonistic, anti-GE people call terminator genes, I think are great things. If we can apply a terminator gene to a tree so that it doesn't have pine cones then we don't have to put up with pollen. We don't have to put up with the energy going into producing flowering bodies instead of wood. And we don't have to put up with wilding pines marching across the hills around Queenstown. That will do me. And to that sort of research, I think New Zealanders will say, okay, now we can see a benefit and no dis-benefit: after all, the thing can't reproduce, by definition.

Given the Government's ambitious goal of returning New Zealand per capita income to the top half of the OECD through the support of research-intensive areas like ICT, biotechnology and creative industries, why aren't we seeing this matched by Government research investment that is higher than the average OECD levels? The OECD average is 0.67 percent of GDP, Australia's is 0.71 percent, New Zealand's is 0.54 per cent.

Someone's done their research there. Very good. And I agree. We are a little behind the pace in our public sector R and D. We've caught up somewhat because I've been pouring money into it. But because the economy has been growing very strongly, GDP is growing and the percentage of GDP figures have therefore been more modest than they should be. Guilty as charged; we are below the average.

Again, our big problem is not public sector investment, it's private sector. So I've doubled the amount of money going into technology for business growth so as to get private sector funding up with help from Government. We've changed tax laws and we're going to have to change them again, I can just see it, especially for venture capital.

Universities are the biggest aggregate providers of research – only just but they are – and they employ increasing numbers of researchers whose careers are at risk from fixed-term R and D contracts. But if you go and have a look at the books of a Crown Research Institute, they don't have any of the room to move that a university has. Apart from the fact that they have a commercial objective on them, they have to earn the rated average cost of capital etc. Leaving that to one side, they don't have teaching research funding. They don't have benefactor funding – you know, trusts where people make over their estates to the universities. So university balance sheets are generally somewhat easier to manage than a Crown Research Institute balance sheet.

Professor David Penny takes highest science award

An evolutionary expert who says meat-eating made us human has been awarded New Zealand's top science prize, the Rutherford Medal.

Professor David Penny, a Massey University biologist, raised vegetarian hackles when he wrote in *Nature* this year that "an increased proportion of meat in the diet of early humans was important for an increase in brain size".

"Apes were mostly vegetarian," he says. When the early ancestors of humans ventured out of the trees a few hundred thousand years ago and started stalking wild animals, they took in new chemical compounds, which enabled brain growth.

"The brain is a very costly organism. It requires a lot to grow it and keep it running," Professor Penny says.

"Since the domestication of peas and beans [a mere 10,000 years ago], we have probably got richer sources of proteins from plants, but of course that's really post being human.

"Now you can be vegetarian and have all sorts of plants that have high amino acid levels. But you probably couldn't have been a vegetarian 50,000 years ago."

Professor Penny, now 66, was born in Taumarunui and raised on a sheep farm near Ohura in the remote southern King Country.

He is now a regular referee for *Nature* and other leading journals and is an expert on evolutionary issues ranging from the peopling of the Pacific to the spread of the hepatitis B virus.

In the late 1990s he led the movement to ban experiments on our closest relatives – chimpanzees, gorillas and orangutans – unless the research also benefited them.

"I think evolution is continuity," he says. "There must be a continuous series of common ancestors of chimps and humans, and the humans have been going out more into the open and have had to learn a whole lot more skills.

"If you look at the chimp and gorilla genomes, you find that the differences from humans are just the normal sorts of changes between any pair of species, so there is nothing special.

"We have pretty well all the same genes. It's often the timing that is different – our brain keeps on developing several years more. It's not that we are different; it's just that we have a much longer learning period."

After New Zealand passed the world's first law protecting the apes, other countries followed.

"New Zealand did it first. It's not that we actually have many great apes, but others have looked at it and said, 'New Zealand has done it, perhaps we should'."

The award coincided with publication of a paper by Professor Penny and colleague Matthew Philips arguing that birds and mammals displaced the dinosaurs gradually during the 20 million years before the disastrous asteroid impact, which is traditionally blamed for the extinction of the dinosaurs about 65 million years ago.

"Although the asteroid at the end of the period was real, we think it's natural evolutionary processes that made the difference," he said.

"We think mammals and birds over 20 to 30 million years were starting to out-compete dinosaurs. From about 80 to 90 million years ago, the birds and mammals were diversifying."

Professor Penny is now delving back further into the past to work out how the first complex living cell with a distinct nucleus evolved about 1.5 billion years ago, producing what is called the "last universal common ancestor" of all plants, animals, amoebas and fungi.

Even further back, he is researching the origin of life itself, perhaps 3.5 billion years ago. It is a riddle he believes scientists will eventually solve.

"The general feeling is that the problem is solvable, and that in itself is quite an amazing statement," Professor Penny says.

The evidence so far suggests that life began in the sea, at a time when the atmosphere outside was inhospitable to any living thing. But earlier theories that life began in hot volcanic underwater vents are now discounted.

"We think there are lots of reasons why it was in a low-temperature place."

The Rutherford Medal

- The Rutherford Medal is awarded by the Royal Society of New Zealand.
- One previous winner was Nobel chemistry laureate Alan MacDiarmid in 2000.
- The 1991 winner, Professor Vaughan Jones, was the first person in the Southern Hemisphere to win the maths equivalent of the Nobel Prize.

Written by science reporter Simon Collins, this article first appeared in the *New Zealand Herald*.

Please reset your watches

A traveller's guide to jet lag

How does a globe-trotting traveller get enough sleep?

Dr Leigh Signal is uniquely placed to answer this question. Holder of a commercial pilot's licence, she is also a Senior Research Fellow at Massey University's Sleep/Wake Research Centre in Wellington.

Dr Signal studied at Massey's School of Aviation in Palmerston North. After completing her bachelor's degree in aviation, she stayed on at Massey and worked as an Assistant Lecturer. When Professor Philippa Gander set up the Sleep/Wake Research Centre in 1998 and invited Dr Signal on board, she jumped at the chance.

"Professor Gander worked on huge field studies on fatigue countermeasures for NASA during the 1980s and 90s. They studied hundreds of pilots in different types of operations and their sleep/wake patterns. Her work has been seminal in sleep research."

"We get fantastic support at the Sleep/Wake Centre for working with industry," says Dr Signal. "We have good research tools and a neat mix of researchers from a range of backgrounds."

"My job brings together two things I love: aviation and research," she says. "It combines my practical background in flying with my interest in aviation-related research."

What is jet lag?

Humans, like most animals, have evolved to match their physiological rhythms to roughly those of a 24-hour day. Every day your body temperature, blood pressure, your levels of stress hormones, even your digestion, follow certain regular 24-hour patterns. For example, 4.30 in the morning is when your body temperature is likely to be at its lowest. At 10.00 in the morning you will be thinking at your fastest. At around 5.00 in the afternoon you will be at your peak in terms of cardiovascular efficiency and muscle strength. This synchronisation to the daily cycle is called the circadian clock, from the Latin for about, or *circa*, and day, or *diem*.

The body's core rhythms – such as body temperature and blood pressure – are largely maintained by two bundles of nerve cells in the brain called the suprachiamatic nucleus (SCN), but there are also peripheral clocks in various tissues and organs.

When you shift time zones, all of these systems are thrown out of whack with each other and the normal night/day cycle. Compare it to an orchestra: at one moment everyone is following the conductor and harmony prevails; at the next there is no conductor and everyone is playing from a different part of the score. We've gone from music to noise.

If we stay in the new time zone, these clocks will all reset themselves eventually. The SCN is reset by cells in the retina of the eye that transmit information about light levels. However, depending on how many time zones you have crossed, the process can take days or even weeks. Until then, you are likely to experience the effects of jet lag.

Beating jet lag

Dr Signal says there is no one-size-fits-all advice for avoiding jet lag.

"Everybody experiences the effects of flight differently. There is too much individual variability to prescribe a single approach. But for someone about to take a long flight from New Zealand, I'd recommend not being sleep deprived before you take off. There's often a lot of running around to be done before a trip, but you don't want to be exhausted before you step on the plane."

"If you need to be fully functioning on arrival, get as much sleep as you can during the flight. People who travel regularly get to know what works for them."

Fooling the body clock

In the laboratory it is possible to adjust people's circadian clocks by exposing them to bright light, the effect depending on when they are exposed to the light, how bright it is, and how long the exposure. But outside the lab this is more difficult to achieve. There are often many other competing cues, such as when you choose to sleep, eat and socialise.

On the other hand there are ways you can make life more miserable for yourself. One of them is to stay up late packing before you leave. Do this, and you are likely to sleep well that night and badly the next, beginning a zig-zag pattern of one good night followed by one bad one.

If you are trying to adapt to your new time zone, you can time your activities to help reset your clock. If you have flown from Auckland to Hong Kong you should try to be outside in the late afternoon; if you have headed to Los Angeles try to be outside in the early morning (this is to allow light exposure to help shift your circadian clock in the right direction). Incidentally, it is easier to adapt to a longer biological day, so the person who has flown west to Singapore is probably going to have a better time of it than the person who has flown east to LA.

What about drugs?

If you mean alcohol and caffeine, then you need to be sensible. Alcohol will certainly help you sleep; it is probably the most widely used sleeping aid we have. The problem is with the quality of sleep it delivers. Alcohol suppresses REM sleep – a cycle of sleep during which the brain is quite active and the eyes move rapidly, hence the name Rapid Eye Movement sleep. If you go to sleep after a few drinks then your REM sleep will be suppressed until your body has processed the alcohol, and then the REM sleep will rebound and your sleep will be restless and disturbed. Remember that your body processes alcohol quite quickly, at about one standard drink an hour – that's a nip of spirits, a glass of wine or half a pint of beer – and you should plan to go to sleep sober.

Caffeine is a stimulant, so is going to disturb your sleep. For most people the stimulant effects wear off after three to five hours, but if you are sensitive to caffeine the effect can last up to 14 hours.

The jury is out on whether sleeping pills are a good thing for long flights. You certainly wouldn't want to wake up groggy during any sort of an emergency. If you do take sleeping pills during your flight, you should probably take them at around the time night would fall in your destination.

When you get to your destination, then taking sleeping pills for the first couple of nights is not unreasonable if you need to function on local time soon after your arrival. Taking the pills probably won't reset your circadian clock, but it ought to mean you are less sleep deprived. You should speak to your doctor first, and try the same sleeping pill at home before you travel to make sure there are no unwanted side effects.

What about melatonin?

Melatonin supplements are touted as a natural remedy for sleep disorders and jet lag. It is a hormone produced in the pineal gland, a pea-sized structure at the centre of our brains. One of the pathways from the SCN (the body's master clock) runs to the pineal gland. Melatonin can also exert an influence on the SCN and it may have a role in influencing sleep. But none of this means you should take it as a drug.

One problem is that melatonin has different effects depending where in your clock cycle you take it. Another more compelling issue is that we don't know enough about the safety of taking melatonin either in the short or long term.

What about the pilots?

If jet lag can have such an effect on the occasional traveller, how do airlines manage the sleeping and waking regimes of their pilots?

International airlines and regulatory bodies wish to set and abide by best practice to make sure that pilots are well rested and alert. Along with her colleague Margo van den Berg, Dr Signal is conducting a study on behalf of the Civil Aviation Authority of Singapore. Singapore Airlines flies new long-range A340-500 jets direct from Singapore to LA, an 18-hour flight. This requires two flight crews working in shifts. Dr Signal's job is to collect data on the pilots' sleep during the flight and to assess their alertness and performance. To measure their sleep she wires them up to sensors which record brain activity, eye movement and muscle tone.

"The flights seem to go quickly because I am busy," says Dr Signal. "But I am shattered when I get to LA – there's no time for sightseeing." Two days later she repeats the data collection on the return flight.

When the study is complete next year, we will have a better picture of how flight crews cope with long-haul flights.

Commuting by air

For Dr Signal, aviation runs in the family. Her husband, Mathew, is a pilot with Air New Zealand Link, so sometimes he gets to drop her off at work. "We live in Gisborne, so this means getting up at 5:15 on a Monday to catch the 6:50 flight to Wellington."

"It's not uncommon for people in the aviation industry to commute by air," she says. "We're moving to Blenheim soon, so my half-hour commute will be similar to someone who travels into Wellington from the Hutt Valley each day."

And how much sleep does a sleep researcher need? "I function best on eight and a half to nine hours' sleep a night – so I'm looking forward to a later start when we move to Blenheim."

Breathless

When Reuben Brickell has asthma it feels as if he is trying to suck air into his lungs through a very small gap. "It's like the air's not plentiful as well. It's like you are trying to grab little snatches of air where you can. It hurts. It's just a really unpleasant sensation."

For the 17-year-old Wellington secondary school student, having asthma is, as he puts it, a real pain in the butt. "When you are running down a road, or trying to get somewhere fast or doing something really strenuous, you are always thinking in the back of your mind: how is this going to affect my asthma? Am I going to need an inhaler?"

So when Brickell was asked to participate in a study on asthma, it was a simple decision. "I can contribute this little bit of my time and if it helps people research towards asthma, something that affects me and affects heaps of other New Zealanders, then why not?"

For many asthma sufferers, the culprit is often assumed to be allergens such as house dust mites, cat's hair or grass pollens. The asthma sufferer becomes sensitive to such allergens, the theory goes, and, with continued exposure, suffers the painful wheezing and the difficulty with breathing that are the result of inflamed airways and a constricted airflow.

But the International Study of Asthma and Allergies in Childhood (ISAAC), which involved more than 700,000 children in 56 countries, has suggested that this view of asthma is too simplistic. The study revealed that the level of allergens could be high in two different countries but the prevalence of asthma would differ markedly.

Another clue that the prevailing view of asthma might not be entirely correct has been the existence of occupational asthma. While the symptoms of occupational asthma resemble those of allergic asthma and are just as distressing, the underlying cause can be something quite different. For cotton workers that might be the bacteria living on cotton; for pig farm workers, the bacteria present in the guts of pigs.

A team led by Associate Director of the Centre for Public Health Research, Dr Jeroen Douwes, has decided to dig into this further. A systematic review of population-based studies of asthma occurrence in adults and children has led the Massey team to think that not all asthma can be attributed to allergens and probably at most only half is caused by allergic reactions. The other half, they suggest, may well be non-allergic reactions.

"If you respond to house dust mites, then automatically people assume it's the house dust mites that cause the disease," says Dr Douwes. "But in asthma I think you have to make a distinction between primary causation – what is really causing the disease – and secondary causation."

To test their idea the team decided to carry out an epidemiological study to see if the participants could be divided into allergic and non-allergic asthmatics. There might even be, according to Dr Douwes, a third or fourth sub-group.

The Massey study contacted 200 high school students from around Wellington who had already participated in the ISAAC survey. All the students underwent a skin prick test to identify anything they would react to, a lung function test, a bronchial hyper-reponsiveness test and, in order to obtain sputum, something called a saline inhalation challenge. (Centre for Public Health Research research fellow Elizabeth Harding went to the University of Newcastle to learn this technique from international asthma expert Professor Peter Gibson.)

The sputum induction, says participant Reuben Brickell, was the least pleasant part of the process. "For the one- and two-minute periods that you do the salt water, it's not too bad, but once you start to get to the five-minute period it begins to grate a bit on your lungs."

But obtaining the sputum was crucial as it was the key to deciding which camp the asthma sufferers belonged to. From the sputum the researchers could disentangle certain cell types and inflammatory markers. The team were hunting for neutrophils and eosinophils, immune system cells that are important in destroying pathogens. For allergic asthma, the team expected to find elevated levels of eosinophils, while in non-allergic asthma neutrophils were expected to be more common.

The team collected sputum samples of sufficient quality from 90 cases and 73 controls. (From the remainder of the children, the team either could not collect an adequate sample, or the children were unable to undergo a saline challenge.)

The team's preliminary analyses indicate

Below: Reuben Brickell volunteers his time as part of the asthma study.

that about 40 per cent of the asthmatic children had increased levels of airway eosinophils compared with about 4 per cent of the control children.

"Although there is a strong association between asthma and airway eosinophilia (as has been reported earlier by others), these preliminary results appear to confirm our hypothesis that a large proportion of asthma may be non-eosinophil-driven," says Dr Douwes. The team's analyses are now focusing on the levels of neutrophil and cytokine, a messenger between immune system cells, in the sputum samples.

As well as the delineating sub-groups of asthmatics, Dr Douwes hopes to tease out if allergic and non-allergic asthmatics are clinically different with respect to the severity of their asthma, their atopy, bronchial hyperresponsiveness and medication use. Additionally, by looking at the information about environments gathered by the ISAAC study, the team also hope to be able to estimate any associations between allergic and non-allergic asthma and factors such as passive and active smoking and family size.

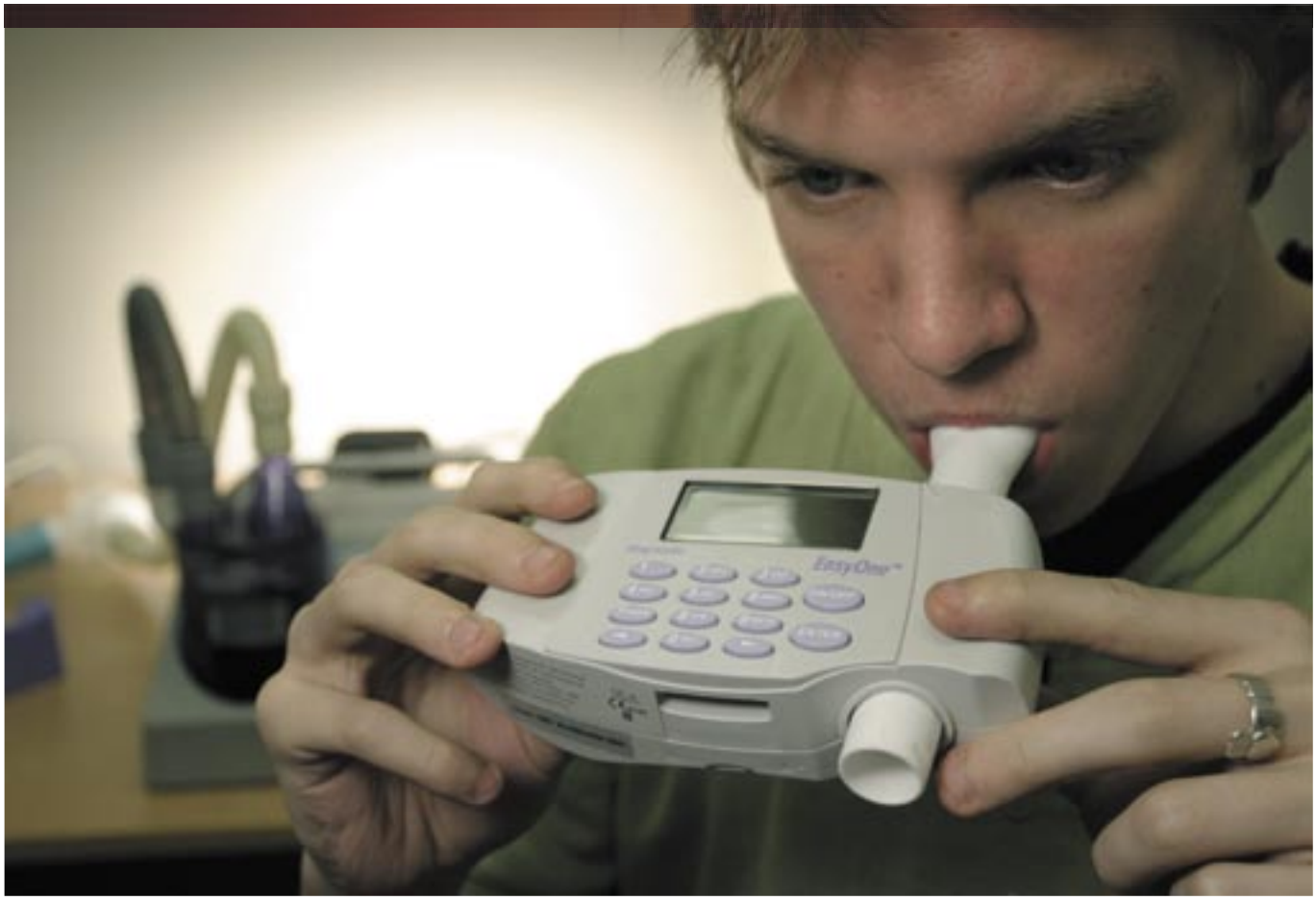
Given the prevalence of asthma here and overseas – the World Health Organisation estimates between 100 and 150 million people worldwide suffer asthma; in New Zealand, it's 15 to 20 per cent of the population – there is surprisingly little agreement on exactly what asthma is. "One of the reasons that we are doing this study is to see if we can come up with a better definition of asthma," says Dr Douwes.

Ultimately the Massey research, funded by the Health Research Council and the Lotteries Commission, could lead to new ways of treating asthma.

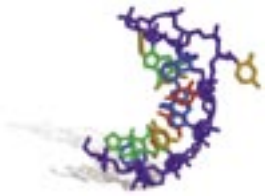
At present the key to counteracting the inflammation of the airways and subduing asthma symptoms is the use of inhaled cortico-steroids, but this treatment does not always work. "It's well known that in some people with severe asthma, even if you treat them with cortico-steroids, or other sorts of treatments, their symptoms don't get better. They clearly have a different sort of asthma that cannot be treated in normal, conventional sorts of ways," says Dr Douwes.

If, as the researchers believe, there are two subtypes of asthma, and if non-allergic asthma is common, then the treatment of asthma could change for a substantial proportion of asthmatics. "Basically, because now intervention or medication is entirely focusing on the eosinophilic airways, and if there is a substantial proportion of the asthmatics that have a different pathology, then maybe those people should get treated differently," says Dr Douwes.

And that could help people like Reuben Brickell with his "pain in the butt" asthma. Says Dr Douwes: "If you want to avoid people becoming diseased, it would be really nice to make them know what makes them sick in the first place. That could lead to primary intervention."



Cold wars



Understand the mechanisms related viruses use to replicate and you should be able to find ways to stop them in their tracks. Dr Steve Pascal is looking at one such mechanism common to viruses that include polio, foot and mouth, SARS and many strains of the common cold.

It begins with an impending sense that something is not right, perhaps a shiver you hadn't expected, or a scratchy feeling in your throat. No matter – versed by experience you know what you have and what you can expect. You have a cold. Ahead lies a week's worth of misery: the broken sleep, bleary eyes, running nose and social unacceptability.

The culprit that has laid you low is a virus, and very likely a picornavirus. Picornaviruses take their name from their size, "pico" being Greek for very small, and "RNA", the abbreviation for ribonucleic acid. Other members of the picornaviruses include the viruses that cause polio, foot and mouth disease and hepatitis.

Compared to our own genome of 3.2 billion paired nucleotides (making up our DNA), that of the picornavirus is a marvel of compression. The pirornavirus keeps its genome as a single kinked-and-twisted strand of RNA just 7,200 to 8,500 nucleotides in length.

Coded within that strand is all the information the virus needs to penetrate a cell, shed its protective protein coat to expose its viral genes, manufacture thousands of copies of itself and disperse.

Viewed at a molecular level the process must be an intricately choreographed wonder.

At Massey, Steve Pascal and his team are examining a particular key part of the viruse genome. The principal tool they are using is a complex technology that applies the workings of quantum mechanics. It is called nuclear magnetic resonance (NMR) spectroscopy.

A native of upstate New York, 41-year-old Steve Pascal's initial academic grounding was in physics; he completed bachelor's and master's degrees in the subject. Then, driven by a desire to see his knowledge turned to practical health-related effect, Dr Pascal joined the biophysics programme at Florida State as a PhD student. His PhD thesis dealt with the biological NMR of small, unusual bacterial peptides. "I liked the idea of being able to point to a picture of a molecule and say, 'This is what we have been studying, and this is how it is related to disease'," he says. In 1993 he took up a postdoctoral fellowship with the University of Toronto and Hospital for Sick Children, "looking at some larger human proteins that were related to cancer." In 1996 he became Assistant Professor of Biochemistry and Biophysics, University of Rochester Medical Center, in upstate New York.

To do medical research "was always a kind of a dream", he says, but so too was teaching physics. In 2003 an opportunity arose at Massey to teach a second-year course in statistical mechanics. Dr Pascal was in a position to take some time away from URMC. "I wanted to try my hand at teaching physics, and I wanted to teach it somewhere interesting

and beautiful," he says. Massey, as Dr Pascal would discover, was advancing with long-held plans to purchase a new NMR spectrometer and cryoprobe. "World-class equipment," according to Dr Pascal, and, at 700 megahertz, with a higher field strength than he had been using in Rochester. "Many people had spent heaps of time and effort to make this happen. Perhaps the only missing ingredient was a faculty member with experience using equipment like this to study proteins and nucleic acids, and that's just what I had to offer. Almost too much of a coincidence."

Dr Pascal found he liked the University and his new colleagues. A vacancy was pending. He decided to stay. In July 2004 the new three-and-a-half tonne of NMR machine was lowered by crane through a retractable roof onto a vibration-free concrete pad in its own purpose-built room.

Just what is a nuclear magnetic resonance spectrometer? In writing about the nearly $3 million purchase, journalists looking for a handy metaphor happened on that of "microscope". This microscope would have a magnifying power equivalent to a telescope which could be used in Palmerston North to view an insect fluttering its antennae on top of the Sky Tower in Auckland. In fact, other than being able to glean information about the very small, the spectrometer is nothing like a microscope. on three stubby legs standing roughly two metres tall. In appearance the 700 megahertz spectrometer is a white bulbous-topped vat close to three metres tall perched on three stubby legs, which rests its on a vibration-free concrete pad.

Nor do the results from an NMR spectrometer resemble anything like the results of an optical or electron microscope. The results of a sample subjected to NMR: a graph showing a series of sharp and broad peaks rising above a flat line. Deeply meaningful peaks for those who know how to interpret them, but nothing like a faithful visual rendering of a hugely magnified molecule.

How does NMR work? Atomic nuclei have positive charges and some – not all, just some – behave as though they are spinning. The spin makes each nucleus behave like a tiny bar magnet. Normally these tiny bar magnets are aligned every which way, but place them in a powerful enough magnetic field and more of them will align with the field than against it. These two orientations are called the low-energy and the high energy state, respectively. Occasionally one of these small nuclear magnets spontaneously flips from one state to the other. However if you supply the difference in energy between the low-energy state and the high-energy state then a lot more flipping will take place as the spin system absorbs the energy. This is known as resonance. In NMR the energy is supplied in the form of radio frequency radiation, which falls nearly into the same band as FM radio broadcasting. After the sample has been pulsed with radio frequency energy, it will "relax" back to thermal equilibrium: the state that existed before the pulses. As it does so it induces a voltage in a surrounding tuned coil of wire, and this voltage – measured, fed through an equation called a Fourier transform and graphed – constitutes the basic results of an NMR analysis.

So here you have the essential components of an NMR spectrometer. A superconducting magnet cooled by liquid helium (which is itself cooled by liquid nitrogen) to -269 degrees celsius. A finely tuned radio transmitter. A tuned coil wire, which surrounds the sample. A sensitive instrument for amplifying and measuring the voltages induced in the coil.

The more powerful the magnet, the greater the sensitivity and resolving power of the spectrometer.

NMR allows the individual atoms in molecules to be identified, and Dr Pascal and his colleagues can also determine how a molecule is structured.

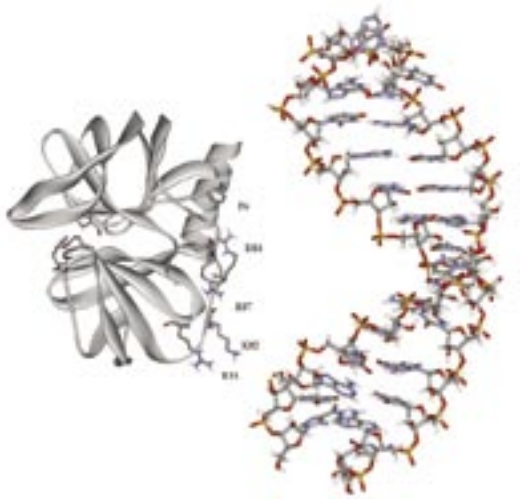
"In a nut shell, you magnetise one atom and then you wait a period of time and see what other atoms that magnetisation spreads to. It will only spread if those two atoms are close to one another," he explains. "For example, if the molecule is a long thread that winds back on itself then you will be able to pass magnetism across the point where the thread meets," he explains.

NMR also makes it possible to work out how inter-atomic bonds are oriented to one another, and Dr Pascal and his colleagues are using residual dipolar coupling, a revolutionary new technique that allows the angles between quite distant molecular linkages to be ascertained.

None of this is straightforward. "You may need to do dozens of experiments," says Dr Pascal. "First, you have to determine which of the hundreds of peaks belongs to what atom – and that can take a dozen or so completely distinct experiments. Then, when you know which peaks are which, you have to do several experiments to find out which atoms are close to one another, which bonds are at what angles to each other, and so on."

In days gone by, the molecular models would be made up by hand, the researcher bending the wire frame of the model to bring two atoms adjacent. Today, many thousands of pieces of information are gathered and fed to computer programmes that generate an ensemble of structures consistent with known angles and distances.

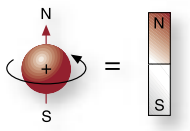
Day three, and it is all turning out as expected. You have abandoned work and taken to your bed, surrounded by wads of tissues and books you can't summon up the concentration to read. Meanwhile the picornavirus is doing just what it is programmed to do: replicating furiously.



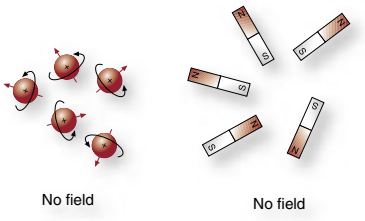
When the 3C protease, at left, binds the stem-loop d portion of the virus genome, at right, it brings with it a polymerase. The protease then cuts itself free and the polymerase begins making copies of the virus's original RNA strand. These templates will be used to churn out copies of the viral polyprotein and to form new virus particles.

NMR at work

Inside the NMR spectrometer the sample is positioned in a magnetic field and excited via pulses of radio frequency radiation. After the sample has been pulsed, it will "relax" back to thermal equilibrium: the state that existed before the pulses. As it does so, a voltage is induced in a surrounding tuned coil of wire, and this voltage – measured, fed through an equation called a Fourier transform and graphed – constitutes the basic results of an NMR analysis. The energy required to flip a nucleus from one spin orientation to the other depends on the magnetic field strength at the nucleus. With no applied field, there is no energy difference between the spin states, but as the field increases so does the separation of energies of the spin states and therefore so does the frequency required to cause the spin-flip, referred to as resonance.



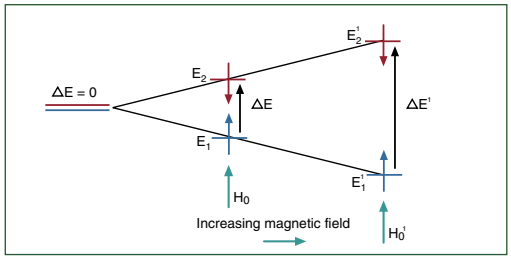
Nuclei with an odd mass or odd atomic number have "nuclear spin" (as indeed do some even-number nuclei).

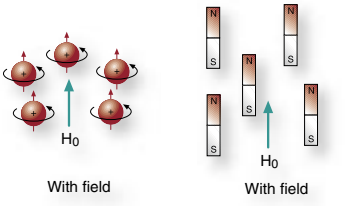


Since a spinning nucleus represents a charged particle in motion, a magnetic field is produced. That means that the nucleus behaves like a tiny bar magnet. In the absence of a magnetic field, these magnets are randomly oriented.

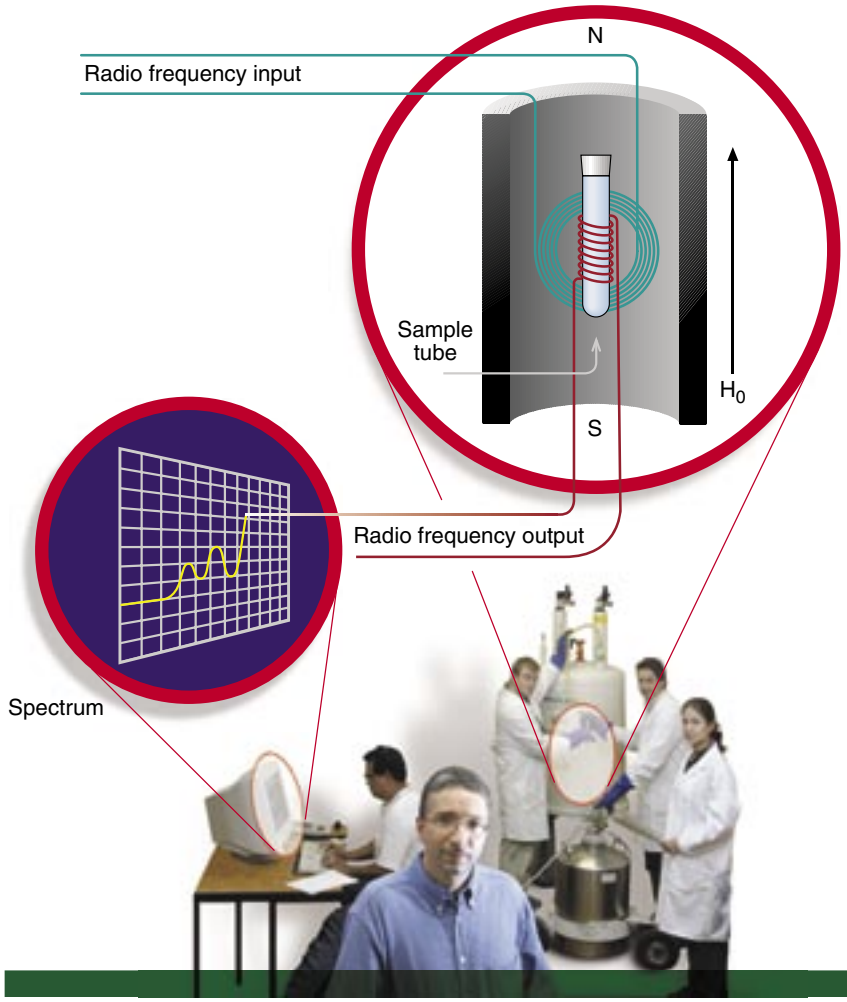
H_0 is the constant magnetic field of the superconducting magnet.

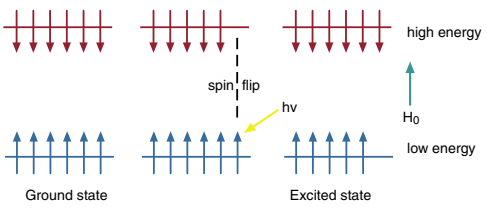
ΔE is the energy of the brief magnetic pulses used to flip the nuclear spins





When atoms are placed in the powerful field of a superconducting magnet, they will tend to align in parallel with the field. This tendency to align, although actually quite weak, is often shown schematically as it is here. The aligned state is named the "low energy state".





Electromagnetic radiation is used to flip the alignment of nuclear spins from the low-energy state to the higher-energy state. The energy required for this transition is proportional to the strength of the applied magnetic field. Afterwards, the spins will "relax" back to thermal equilibrium: the state that existed before the pulses. The resulting electromotive force induces a current in the sample coil, which gives rise to the NMR spectrum.

Normally your cells use their DNA to create messenger RNA (mRNA), which then forms the template for creating proteins. Picornaviruses are called positive sense viruses because their RNA functions in the same way as mRNA: as soon as it enters the cell cytoplasm it is able to start manufacturing protein. And this is what it does, creating a single large polyprotein. Even while the polyprotein is being formed it is being cleaved into smaller sections by enzymes called proteases. One of these sections will be an RNA polymerase – an enzyme that makes RNA – which will use the single-stranded RNA from the virus to create a number of complementary copies of the virus's original RNA strand. These templates will begin churning out copies of the virus's original RNA, which can, in their turn, begin producing those single large polyproteins. And so it goes on, in a cascade of replication.

Meanwhile, among the cleaved sections of the large polypeptides will be multiple copies of the protein set aside for building the capsules, or capsids, for the next generation of viruses. These will be broken by proteases into complexes of four proteins, and these complexes will aggregate together to form five-sided, ring-like pieces of molecular scaffolding. Twelve of these will mesh with one another to form a geodesic soccer-ball-like capsid around a copy of the RNA genome.

Dr Pascal's interest is in the 5' end of the viral RNA strand. Remember how the viral RNA codes for a single polyprotein? Well this is so only of most of the RNA. At the 5' end of the RNA strand sits a 600-1200 nucleotide "complex multiple cloverleaf" structure that does not code for anything, but is nonetheless significant.

The single polyprotein first produced by the viral RNA contains at least two proteases (the enzymes that cut proteins into pieces). One of these, a protease designated 3C, begins life attached to the RNA polymerase. Before cutting itself free from the polymerase, the protease first binds to part of the cloverleaf structure. This puts the polymerase in a position where it can begin the business of replicating the viral RNA.

Day five and you are beginning to feel better. Your immune system has kicked in and you are hoping you haven't given the cold to anyone else – particulary anyone close to you. Fact of the day: during the average person's lifetime he or she will catch 140 or so colds.

One of the reasons you will catch so many colds is because the picornavirus keeps its genome as RNA, which is much less stable than its deoxygenated cousin DNA and can easily break and reform. Because the cold viruses are forever mutating, your immunity to one cold is unlikely to protect you from the next. But some parts of the genome – such as the structure Pascal is studying – must remain intact for the virus to function. If the protease could be prevented from binding to the cloverleaf structure, then the polymerase would never arrive at the right molecular destination and there would be no replication.

A single custom-made, well-placed piece of molecular grit dropped into the mechanism would do it. (What is more, much the same technique could also be applied to the coronaviruses – SARS among them – which share similar structures to the picornaviruses.)

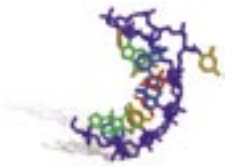
So while Dr Pascal isn't promising any imminent cure for the common cold, his collaborative work in deciphering the structure of picornaviral RNA and its complex with the viral protease could lead to a chain of research that does.

"What we'd like to do is to set up collaborations with people who synthesise molecules which may mimic the segment of the RNA or the protease that we are interested in," explains Pascal. The molecules would interfere with this key interaction. This also presents challenges, as molecules in the form of a protein or RNA generally won't work. "Proteins tend to be chewed up by other proteases; they will be digested, and RNA is also very unstable," says Dr Pascal. "So you produce something that maybe has the same shape but does not have peptide bonds or phospodiester linkages that are so susceptible to degradation."

Day seven. The virus has run its course and you are feeling buoyant with relief – as you do. This cold is done with. Until the next.

Chicken soup and the over-the-counter remedies: until now the treatment of colds has largely meant treating the symptoms and waiting on your immune system to deal with things. But this need not be for very much longer.

If the 1950s were the golden age of antibiotics, then science's ability to read the viral genome using tools like NMR spectroscopy could make this the golden age of antivirals.



At Massey, Steve Pascal is part of a new NMR team that includes postdoctoral fellow Stephen Headey, PhD student Jo Claridge and technician Dr Giselle Soares. "We are also working on ways to incorporate the complementary technique of X-ray crystallography, as Massey is home to a number of talented crystallographers," says Dr Pascal.

Internationally, Dr Pascal is working with Kaushik Dutta and David Cowburn of the New York Structural Biology Center (NYSBC), Vivek Rangnekar of the University of Kentucky, Huang He of Vaccinex Inc. and Daiwen Yang of the National University of Singapore (NUS). Dr Pascal gives particular credit to Dr Huang, who established the RNA project as a member of Dr Pascal's Rochester laboratory, and Dr Dutta, who has been instrumental in all of his current research projects.

While waiting on the arrival the 700 MHz spectrometer and cryoprobe, Dr Pascal was able to have spectra done through his collaborators in New York and Singapore. Now Massey's equipment is in place, Pascal hopes to see it widely used by other New Zealand and international university researchers.

Pascal has plans to use the spectrometer to conduct research into neurodegenerative diseases such as Alzheimer's and Parkinson's.

How to be the perfect host

Professor Yusuf Chisti is a world expert in the production and processing of biotechnology products.

In a milky, nutrient-rich broth in a glass bioreactor at AgResearch myriads of bacteria are dividing and growing.

When harvest time comes, a few drops of a chemical inducer will be added to the solution, a gene will switch to 'on', and small bodies in the bacteria called plasmids will begin industriously fabricating a protein to order. So much protein will accumulate that the cells will create so-called inclusion bodies to contain it.

The protein is an antigen, a substance that stimulates the production of antibodies in animals injected with it. This antigen is normally associated with the eggs of a hydatid tapeworm. The bacterium is a modified version of the rod-shaped *Escherichia coli* bacteria which live in animal intestines, including our own. It has no use for the protein.

But a sheep vaccinated with the protein will develop an immunity to hydatidosis, a disease, which, while officially eradicated from New Zealand in 1999, continues to flourish in other parts of the world, infecting and sometimes killing human hosts.

In another bioreactor a genetically engineered yeast is producing follicle-stimulating hormone (FSH), which can be used to induce 'superovulation' – the development of more than the usual number of mature eggs – in humans and other animals. This is ovine FSH – the FSH produced in sheep.

In a third bioreactor, ovine FSH is again the product, but this time the cell line is a gene-recombinant CHO (Chinese hamster ovary) cell favoured by researchers.

Masterate student Daniel Manderson's interest in this is not in the technology that has cut and spliced the genes from one organism into another. Supervised by Massey's Professor Yusuf Chisti and Dr Robert Dempster of AgResearch, he is setting out to create the perfect environment for these very different cell lines to grow and thrive. Inside each vat, nutrients and oxygen must be delivered in precise quantities, the optimum temperature and pH maintained, and wastes removed.

These bacterial, yeast and mammalian cells are picky about their living conditions. Manderson's task is to make AgResearch the perfect host.

For millennia humanity has turned micro-organisms and their natural by-products to its advantage. Yeasts have converted sugars in grape juice to the carbon dioxide and alcohol in wine, and bacteria have cured cheese since well before anyone had an inkling that there were such things as yeasts or bacteria. In the last few hundred years smallpox vaccines have been made from viruses and, in the last 60, penicillin has been manufactured by culturing moulds. (Alexander Fleming, who discovered penicillin, is famed; the fermentation expertise in the US that made penicillin a cheap wonder drug is less well known.) This is all part of the biotechnology industry's lineage.

But the biotechnology phenomenon – biotechnology as stock market darling and harbinger of a brave new world – is recent.

All life as we know it – be it bacterium, beech tree or banker – shares a common origin and a common code, written in DNA's iconic double helix of base pairs between two strands of nucleic acid. DNA, to oversimplify, does two things: it produces copies of itself, and it produces RNA, which makes proteins.

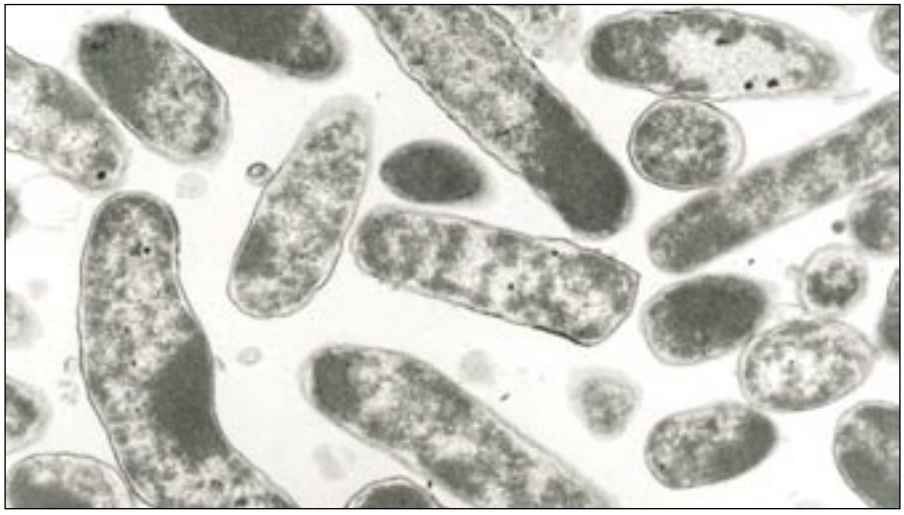
The structure of DNA was postulated in 1953, but it took time to tease out the implications and longer still for there to be practical applications. DNA was effectively 'read only'. Then in 1972 Paul Berg published a paper announcing the cutting and pasting of DNA between *E. coli* and a virus. His techniques, it was apparent, would have wide application. If you could transplant DNA you could make proteins to order.

One of the first breakthrough uses of gene recombinant technology was in producing insulin used in the treatment of diabetes. Until then the insulin was sourced from pigs, cattle and human cadavers. Insulin is produced in the pancreas, and pancreas cells are difficult to culture. By contrast *E. coli* – the rod-shaped intestinal bacterium we met earlier on – is a breeze. In 1979 recombinant *E. coli* was persuaded to produce the components of insulin. In 1982, synthesised insulin produced by genetically altered bacteria was approved for use with insulin-dependent patients.

The air was heady with possibilities.

Professor Yusuf Chisti is an energetic, olive-complexioned man with a transatlantic accent touched with a dash of somewhere else. This proves to be Nigeria, where the Pakistan-born Chisti spent his life between the ages of nine and 20, when he completed his first degree, in chemistry at the University of Jos.

Master's student Daniel Manderson examines one of the cell cultures being grown at AgResearch. (Photos courtesy of AgResearch)



Gene recombinant *E. coli* bacteria showing inclusion bodies – the darker regions – where foreign proteins are isolated. The protein being produced here is used in a vaccine that can protect sheep against hydatidosis, a disease eradicated in New Zealand but still prevalent in many other parts of the world. AgResearch, which developed the vaccine in collaboration with Melbourne University, has commercial partners in China and Argentina.

Industry training programme to be piloted

A $400,000 pilot programme to develop industry training within the biotechnology sector has been announced by Pete Hodgson, Minister of Research, Science and Technology. The programme will be led by Professor Chisti.

The pilot programme will run high-level, enterprise-specific modular workshops for biotechnology firms. The content of the workshops – expected to concentrate on the areas of biotechnology science, processing, regulatory compliance and business – will be developed in consultation with industry

"We have already proven that New Zealanders are world beaters in biotechnology. This initiative will help consolidate and grow that position," said the Minister.

The project will also call on Professors Ian Maddox and Richard Archer of the Institute of Technology and Engineering; Professor Barry Scott and Associate Professor Bernd Rehm of the Institute of Molecular Biosciences; Associate Professor Alan Murray of the Institute of Veterinary, Animal and Biomedical Sciences; and Dr Gavin Clark of Research Services.

The pilot forms part of the Government's Growth and Innovation Framework, which is funded through the Tertiary Education Commission's contestable funding initiative and is intended to promote closer collaborations between tertiary education organisations and industry.

Professor Chisti's choice of major was driven by pragmatism: Jos did not teach engineering and Professor Chisti did not think of himself as strong in mathematics. His choice for his second degree was driven by ambition: "I wanted to get into something 'hot'," he says.

So in 1979 – that same year insulin was first produced – Professor Chisti headed to University College, London, to begin a masterate in biochemical engineering.

After completing his masterate, and two years of teaching back in Nigeria, Professor Chisti followed with a PhD in biochemical engineering at Waterloo University in Ontario, Canada. His thesis topic was airlift bioreactors. Professor Chisti would go on to literally write the book on bioreactors: *Airlift Bioreactors* by Yusuf Chisti was published in 1989 and has been cited in the academic press on average once a month ever since.

Above Professor Chisti's desk is a strange calendar. It features page-on-page of bioreactors: gleaming stainless steel tanks with tubes, valves and gauges. The lighting is an eerie blue; the settings are aseptically clean and ordered. At least one of the pictures has classical art works set about the stainless steel. Of people, there are none.

Bioreactors are fundamental to the biotech industry. The stainless steel bioreactors used in the production of human therapeutic proteins will usually run to a volume of between 2,000 and 10,000 litres, though some reach volumes of 100,000 litres. The most common are stirred-tank bioreactors, with the stirring being provided by impellers that resemble boat propellers. But with this method of mixing comes shear stress. "Just as when you have a storm, the wind can uproot trees or lift roofs, the forces in a liquid can tear apart suspended cells," explains Professor Chisti.

In an airlift bioreactor the circulation of fluid is driven by the release of gas into the lower portion of the bioreactor and a draft tube helps ensure thorough mixing without creating disruptively strong currents.

Recently Professor Chisti has been experimenting with the use of carefully calculated levels of ultrasound, which has been shown to improve mixing and lift cell productivity.

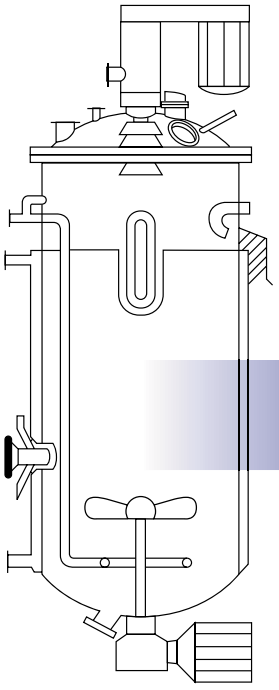
On finishing his PhD and completing a one-year postdoctoral fellowship at Waterloo, Professor Chisti joined a wealthy biotech start-up, Chembiomed, in Edmonton. Here, as one of their 100 or so employees, Chisti designed and built the first GMP (Good Manufacturing Practice) compliant monoclonal antibody production facility in Canada.

Monoclonal antibodies are used in diagnostic tests, or assays. The diagnostic test for HIV AIDS uses monoclonal antibodies, as does the over-the-counter home pregnancy testing kit. Professor Chisti's facility produced the monoclonals used in testing for blood types.

The 'monoclonal' part simply refers to the antibodies all coming from clones of a single cell.

Although human and animal cells produce antibodies, there is a problem with using these cells for commercial production: after dividing a number of times, the cells die. To get around this, the practice is to take the cell that produces the antibody and fuse it with a cultivated tumour cell, producing an immortal cell line called a hybridoma. Usually these are mouse cells.

Hybridomas, being sensitive to shear stress, are best cultured in airlift bioreactors.



The schematic for a stirred-tank bioreactor. An airlift bioreactor uses the release of gas rather than an impeller to provide mixing.

In 1991 Professor Chisti returned to Waterloo as an adjunct professor. His next move was to the south of Spain in 1997.

"I had a postdoctoral visitor working with me when I was in Canada, and he became a professor at this Spanish university, and invited me to come over. So I spent three-and-a-half years in Spain in a pleasant town called Almería right on the Mediterranean coast across from Africa," says Professor Chisti.

At Almería Professor Chisti taught postgraduate students and became involved in the research administration relating to projects sponsored by the European Union. He also developed an enduring interest in microalgae.

Canada had been cold. In Waterloo the average temperature in January is minus 8 degrees centrigrade; in Edmonton it can hit minus 40.

By contrast, Almería has more cloudless days than any other region in Spain, and its average temperature is 18. It is a setting that lends itself to the filming of westerns, holiday houses for jaded Brits, and, with its warm temperatures and seawater, the growing of microalgae.

Currently microalgae, which make up 60 percent of the Earth's primary productivity, are scarcely used in commercial processes. This is not to say they have no uses at all. Spirulina, a cyanobacterium, is sold in the form of drinks and health food supplements. Chlorella, a microalga, is another health food supplement. In Western Australia a microalga is farmed for the production of beta carotene, a substance found in fruit and vegetables. Beta carotene is used as a food colourant, dietary supplement and an ingredient in cosmetics. In places like Hawaii and California a microalga is grown to be harvested for astaxanthin, the red-orange pigment that makes salmon pink and lobsters red.

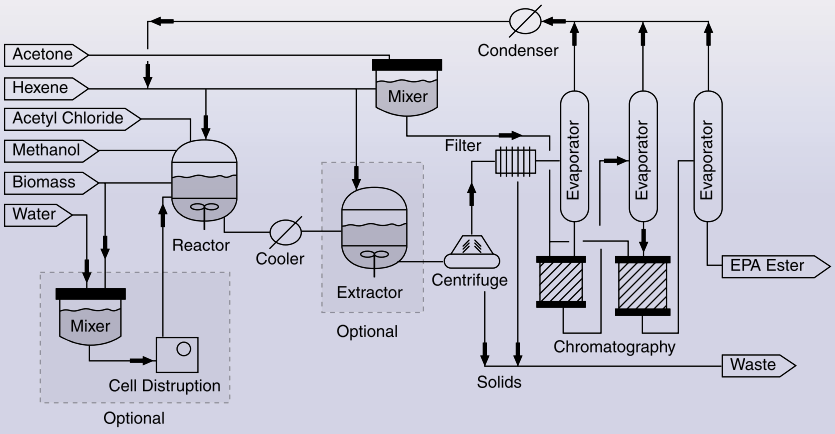
Astaxanthin sells as a nutraceutical and an aquaculture foodstuff, and as an ingredient in various cosmetics. These are valuable products. "Astaxanthin sells for something like $3,000 per kilogram," says Professor Chisti.

In aerial photos, the outdoor ponds used for growing microalgae look like vivid daubs of paint: iridescent green and dayglow orange.

In Almería, Professor Chisti began growing microalgae not in open ponds, but in a contained environment – a photobioreactor – away from all possible contamination.

At one end of the photobioreactor is an airlift pump to produce flows, while most of the reactor takes the form of looped series

At Almería in Spain a pilot photobioreactor cultures a microalga which will be harvested and processed to produce EPA, a valuable omega-3 oil. Although the extraction process – shown below – is sophisticated and costly, for high-value products the use of photobioreactors is approaching commercial viability.



of perspex tubes. Cultivating organisms that are light-dependent introduces another set of factors. Within the bioreactor there will be many different zones of illumination; where an organism sits within the culture will determine how much light it gets.

Strangely enough, one of the health discoveries of recent years – that eating fish seems to confer some protection against heart attacks – may in fact be attributed to microalgae. The omega-3 oils found in fish originate not in the fish themselves, but in the algae they feed on.

The fatty acids in omega-3 oils reduce blood clotting by decreasing the stickiness of blood platelets and, it is thought, may play a role in stabilising heart rhythms and reducing inflammation.

Professor Chisti's interest has been in the feasibility of producing one particular omega-3 oil called eicosapentaenoic acid (EPA) directly from microalgae. EPA and its derivatives have proved useful in preventing and treating coronary heart disease, abnormal cholesterol levels and several carcinomas.

Currently the only commercial source of EPA is fish oil, which fluctuates in price and quality, and can be subject to contamination with pesticides and heavy metals. Moreover, the demand for EPA is growing while the supply is fixed.

In Almería the photobioreactors were set up to culture the EPA-rich microalgae *Phaeodactylum tricornutum*. Typically for products like EPA 70 to 80 percent of the total cost of production will be in the processing and recovery. In this case processing and recovery meant three steps: extracting the fatty esters from the algae, separating EPA by pushing the dissolved fatty esters through columns of silver silica gel, and finally removing the chlorophylls. Professor Chisti and his collaborators calculate that producing EPA from microalgae will be cost competitive with fish-oil-based EPA if the algae can be harvested for less than US$4 per kilogram.

In 2000 Professor Chisti applied for his current job based at Massey's Palmerston North campus. He had enjoyed living in Almería, but never really came to grips with colloquial Spanish.

Today much of his research work is carried out in collaboration with former colleagues in Waterloo and Almería. He is soon to fly to Almería to conduct a PhD examination of a student whose work has been in producing the cholesterol-lowering drug lovastatin from gene recombinant moulds.

Professor Chisti's New Zealand-based postgraduate students are looking at such things as removing phosphate from wastewater and the enzyme treatment of hides to remove wool. Daniel Manderson, with whom this article began, is now in Ireland, where he will very likely end up employed by the biopharmaceutical industry, as happens to many of Professor Chisti's former students.

For Professor Chisti, biotechnology retains the allure and excitement that first attracted him as a student. In no other industry, he says, is there so close an alliance between knowledge and wealth creation, between commercial success and research expertise. Many biotech companies are pure research entities, contracting out the application of their research, and many universities end up spinning off biotechnology enterprises.

In the United States the biotechnology industry is again riding a wave of investor confidence. There have been company failures, as is to be expected, but the companies succeeding are doing so spectacularly well. "I have just been looking at a company called Invitrogen," says Professor Chisti. "In 1999 their revenue was around US$93 million; last year it was US$778 million!"

And all this is but a foretaste of what is to come. An editorial Professor Chisti has written for *Biotechnology Advances* is provocatively headlined 'Who needs a conventional dairy industry?'

"Why not microbial milk?" the editorial asks. Many of the soluble compounds in milk are already being made by recombinant organisms. Microbial milk would mean ground water uncontaminated by nitrates. It would be pesticide and antibiotic free. It would be cheaper too (though the branding campaign could pose problems).

Professor Chisti is being provocative – playing to the 'yuck' reaction – but his question is a proxy for those other larger ones: Where will biotechnology take us? How will it benefit us? What might it cost us?

Who is to say?

A few small problems

Find the protein that interests you, find the gene that produces it, take that gene and paste it into a helpful bacterium, and then produce any amount of the protein you like. It is a lovely concept beset by practical difficulties.

One of the difficulties is that organisms, such as *E. coli* and mammalian cells, produce different types of proteins. Many human and other mammalian proteins have carbohydrates attached to them, a condition termed glycosylation. Most of the proteins produced by bacteria are not glycosylated. So to produce many proteins you must use a mammalian cell line – and mammalian cells will divide only so many times before dying.

To get around this limitation, extensive use is made of hybridomas: cell lines created by fusing a cell that produces the protein wanted with a tumour cell, which will go on living and dividing long after an ordinary mammalian cell would have died.

However, even these techniques may not work where the target product is the result of complex biosynthetic pathways in cells that have a limited life.

Sponges have been of great interest to researchers looking for bioactive compounds. Sponges are soft, immobile and outwardly seem essentially defenceless, so you might expect that their chemical defences against predators would be highly sophisticated, and so it proves.

Two antiviral drugs already on the market, Acyclovir, a treatment for herpes, and AZT, employed against HIV AIDS, can track their lineages back to compounds isolated from a Caribbean sponge, *Cryptotheca crypta*, in the 1950s.

But generally researchers are having great difficulty in producing enough of the compounds of interest. Many arise not out of the action of one gene, but of many, so transferring a gene may not work. And, as with mammalian cells, growing sponge cells in a bioreactor is also difficult: after a certain number of multiplications the cells die.

The ideal, as with mammalian cells, would be to cross a sponge cell with a sponge tumour cell. But, according to Professor Chisti, who was part of a team that investigated the cultivation of sponges, no sponge tumour cells have yet been found and attempts to produce cancer in a sponge have been unsuccessful.

Industry links vital

Partnerships between universities and New Zealand's biotech sector are an ideal opportunity to ensure the critical needs of the industry are met, writes NZBio CEO Brian Ward.

Initiatives that encourage collaborations between universities and the biotech industry benefit both on a number of levels. They allow businesses and tertiary institutions to exchange knowledge, giving companies insight into research projects and researchers insight into the world of commercialisation.

Academic staff can provide expertise and skills to address the needs of companies as they develop. This is a great advantage for small firms, who, while they may be specialists in their own area, often don't have in-depth or detailed information about other topics.

Universities are also an important resource for continuing education, providing an opportunity for those already working in the industry to up-skill or broaden their field of knowledge.

As with any industry, the courses universities offer must be relevant to the biotech sector, and match its demands as these unfold. It is vital that training and development priorities and emerging trends are identified early enough to be incorporated into study programmes.

That is why it is essential that tertiary institutes and biotech companies continue to work together, to make sure we address any knowledge gaps and have the capacity to take part in and drive the industry forward.

By working together, students, university staff and established biotech firms strengthen their own networks, and diminish the sometimes perceived barrier between academia and 'the real world'.

These kinds of collaborations can provide opportunities for future employment, as well as giving students an idea of the career options available to them. Nothing beats practical experience for finding out how your skills fit the industry.

This is where a truly well-rounded education is so important. It is becoming increasingly apparent that to succeed in the biotech industry today, you need to have a variety of abilities, not just technical expertise, but commercialisation skills and business know-how.

While it will always be important to have world-class science capabilities, we should recognise that practical industry experience is also very valuable.

Brian Ward
CEO, NZBio

It will taste delicious, and

Professor Paul Moughan is an apostle for the coming functional food revolution.

I have always admired the University for its research ethos and that real hands-on approach which ensures relevance.

In a Wellington supermarket I am scouting for elements of the functional food revolution I have been told is building. To be honest, I haven't found much. Sure, there are breakfast cereals enriched with vitamins and minerals, but these hardly count.

It's not until the dairy section that I find what I want: yoghurts laced with 'probiotic' cultures of bacteria that promote healthy digestion, alongside statin-containing spreads that cut cholesterol. Then as I carry my purchase to the counter – as if to clinch the argument that functional foods have arrived – packets of chewing gum promising to whiten my teeth. Didn't chewing gum used to be bad for you? None of these products were on the shelves a decade ago.

Functional foods, according to one definition, are foods designed to provide a specific and beneficial physiological effect on health, performance and/or well-being extending beyond the provision of simple nutrients.

Iodised salt, with the protection it offers against goitres and cretinism, is an archetypal functional food. But adding iodine to salt, or vitamins and minerals to a breakfast cereal, is hardly to be compared with the precision and sophistication with which foods are now being engineered to confer benefits.

Many of our afflictions have some dietary component. Think of obesity, hypertension, coronary heart disease and osteoporosis. By choosing a conventional diet carefully you can influence your health, but this falls well short of being able to choose foods designed to be good for you, their efficacy scientifically proven.

If, instead of turning to modern medicine, you could improve your health by adding functional foods to your shopping list, wouldn't you do so?

And if the market for functional foods does take off, wouldn't New Zealand, a nation that derives more than 50 percent of its income from food exports, want to be a major player?

In his office on the Palmerston North campus, Professor Paul Moughan, co-director of the Riddet Centre, is upbeat about what lies in prospect for New Zealand. He has spent 20 years in food and nutrition research. He has seen functional foods begin to penetrate the marketplaces in Finland, Sweden, Japan and America. And whereas many scientists lament the lack of private sector funding in New Zealand, Professor Moughan is having little difficulty in attracting backers.

"I find the major primary industries in New Zealand are highly motivated to do research that will add value. We've got a large project with Fonterra, we've got a large project with Meat and Wool New Zealand, and both are about discovery-based research to come up with new and innovative products. That's exactly what the Government wants to happen in the economy.

it will be good for you

"These industries are investing in R and D, they do want to innovate and they are innovative industries," he asserts, as if parrying an attack.

Good things lie ahead: "We have great raw materials, the clean, green 'brand New Zealand', and excellent science." Much of that excellent science will come from the centre he heads.

The Riddet Centre was set up in February 2003 with Professor Moughan and Professor Harjinder Singh as co-directors. (Professor Singh, an acknowledged world leader in the science of food structure and functionality, has an office close by Professor Moughan's.) Carrying the tagline "advancing knowledge in food and biologicals", the Centre brings together expertise from Auckland, Otago and Massey Universities – as well as overseas institutes. Its twin objectives are scientific excellence and industrial relevance.

If things go the way they should, the PhDs, post-docs and Riddet Centre Visiting Fellows hosted by the Centre will seed the New Zealand food industry with fresh expertise, and the science performed under the aegis of the Centre will both address fundamental questions and find practical – and lucrative – applications.

How well do we understand the links between nutrition, digestion and health? As the recent debates surrounding weight-loss diets have shown, not as well as perhaps most people assumed.

Much of our food wisdom, says Professor Moughan, has been less science than it has been anecdotal. Our commonly accepted truths have often been derived from applied rather than fundamental research. "We need to better understand the underlying mechanisms," he says.

"I think over the next decade you are going to see a lot more fundamental science applied to the unravelling of the mysteries of and contradictions in human nutrition."

Professor Moughan first began to confront just how complex the mysteries were when he chose his PhD topic back in the early 1980s: the digestion of protein and the post-absorptive metabolism of amino acids, using the rat and pig as general mammalian models.

On the face of it you might think that finding out what goes on with the digestion of proteins is easy. Measure the amount of protein that is eaten, subtract the amount of protein that is voided, and there you have it: the protein that has been digested.

But, as Professor Moughan points out, a lot of the protein that is being digested comes not from food but from the animal itself. "In any one day very large quantities of gut protein are completely broken down and completely resynthesised. It is an energy-demanding process."

Professor Moughan's work helped distinguish between the 'exogenous' digestive processes driven by the digestion of food and the 'endogenous processes' driven by the recycling of protein. "We were the first group in the world to show that peptides from protein have a major regulatory effect on gut protein turnover," says Professor Moughan.

He also took an early interest in the bioavailability of lysine, one of the handful or so amino acids that humans cannot fabricate and so must come from the diet. Lysine is particularly important as a first-limiting amino acid: the amino acid present in the least amount in food relative to its requirement. This key amino acid also happens to be very susceptible to chemical damage during food processing and storage.

"We came up with what is credited as being an original way of describing lysine left in food that hasn't been damaged and is available to be metabolised," says Professor Moughan.

Most research until then had concentrated on describing the chemistry of the changes that take place when lysine is heated. Professor Moughan stood this on its head by looking at the chemistry of lysine molecules that remain unchanged.

He developed a new biological assay – now internationally known as the Massey assay – to measure the availability of lysine in foods. "We've had a lot of food companies come to us from all round the world and ask us to put material through that assay and tell them in terms of the chemistry what happens when they do different things to foods."

Professor Moughan's invention, with Mr Shane Rutherfurd, of a bioassay for determining amino acid bioavailability in food has been patented and trademarked (Biolysine‰) and has returned a not inconsiderable fee income over the last five years.

His work on protein metabolism and on lysine, which has involved some highly original experimental approaches, has resulted in well over 200 scientific papers. This, he says, is the work on which his Doctorate of Science was based, as well as the work for which he is best known in the scientific community. It is this work to which he attributes the conferral of a personal chair at a young age, a Fellowship of the Royal Society of New Zealand, and more hosted invitations to speak internationally than he could ever hope to accept.

Professor Moughan's work on the digestion of protein continues. "Lately we have been undertaking detailed studies with human subjects. We have shown that there is a dose-dependent effect of proteins on gut protein turnover and we are now trying to look at underlying molecular mechanisms. If we can understand and manipulate what is going on, then there could be all sorts of ramifications for gut function and health." The University of Paris is a research partner.

Professor Moughan's academic productivity becomes more remarkable when you consider that in parallel with his research career he has built and run a series of highly successful university research and teaching units.

His first was the newly established Monogastric Research Centre, of which he became Director in 1991. The Centre worked on the biology of simple-stomached animals, such as humans, production animals such as poultry, pigs, and companion animals such as dogs and cats, and even fish. During Professor Moughan's five-year stewardship the Centre grew from four to 50 staff.

From 1995 to 1998 he held the position of foundation scientific director of the Milk and Health Research Centre, which Professor Moughan describes as having concentrated on functional foods for humans, and, from 1997 to 2003, the foundation headship of the Institute of Food, Nutrition and Human Health.

After years of steady growth, the Institute now has around 165 staff and 160 postgraduate students. It is, Professor Moughan says, the most outstanding institute for food-related research in the southern hemisphere. "I think you can say that without fear of contradiction."

By contrast the Riddet Centre is a minnow. Here there are just 20 staff. But it is a prosperous minnow: in the first 18 months of its existence the Centre has attracted more than $10 million in research funding. It is also of the highest quality. In terms of the New Zealand Government's PBRF exercise the Centre ranks right up there among the best academic units in the country.

With less administration, Professor Moughan says he is enjoying the luxury of more time in which to research, think and write.

A large part of the Riddet Centre's private sector research funding – around $5.8 million – is coming from Fonterra and BASF for the development of what are being termed POSIFoods or "point-of-sale individualised foods". Fonterra is the fourth largest dairy company in the world by revenue, and second in the volume of milk processed annually; BASF is, among other things, one of the most important producers of vitamins worldwide.

POSIFoods will be fast, nutritious snacks tailored to individuals' dietary needs and taste preferences, delivered at the touch of a button.

"The idea will be that you'll say you want a low Glycaemic Index, high antioxidant, such-and-such a food and you want this colour, flavour and serving, and you'll push a button and out it will come. It will taste delicious and it will be fantastic for you – and all proven by science done by Massey University in partnership with Fonterra and BASF scientists," says Professor Moughan.

POSIFoods will solve one of food manufacturing's eternal problems: storage. "I don't know if you have ever bought one of these sports bars or a low GI, high-fibre type bar. The problem is they often taste horrible. Given what they are made of, they stale very quickly. They sit on the shelf and they go hard, have that cardboardy feel to them. If you could make them fresh and have them warm, just out of the oven, it would be a completely different story. It's like hot bread or a hot muffin. Manufacturing and dispensing the food fresh gets around the technical problems with storage."

Courtesy Rodd Emmerson and *The New Zealand Herald*

Professor Moughan already had an established relationship with Fonterra, and close connections with the conglomerate BASF, which helped him attract their interest in becoming a research partner. The POSIFood team includes Professor Moughan's colleagues at Otago and Auckland Universities as well as Fonterra and BASF scientists.

"We hope that within a year we are going to have a prototype device – a proof of concept – that will deliver the food at the point of sale," says Professor Moughan. "We are talking about something big."

The second largest of the Centre's research contracts is with Meat and Wool New Zealand for the extraction of specialised ingredients from meat for the development of functional foods.

While the dairy industry increasingly breaks milk into its molecular constituents to sell at a premium, the meat industry has changed less in the last 50 years: its trade is largely in cuts of meat and processed meat products. Yet the proteins in meat represent a bonanza of functional food ingredients and bioactive compounds.

Not all of the protein you eat is metabolised by your body, explains Professor Moughan, and if your health is at all compromised – if you are perhaps elderly, recovering from illness or injury, or malnourished – then the quality of protein you get becomes important.

The Riddet Centre intends to extract many different kinds of protein from animal tissue and to break these down to form new food proteins. "Specialised protein ingredients with very high amino acid availability," says Professor Moughan.

"We then might come up with a food for the elderly, for example, who are losing muscle mass, and come up with a balance of amino acids that will specifically meet the requirements for people in that physiological state."

The Riddet Centre team will then spend some time in France working with colleagues at the University of Paris and INAP-G, where these foods and protein mixes will be fed to human volunteers to prove their efficacy.

Professor Moughan also believes that when the proteins are broken down to produce the linked amino acids called peptides "a cornucopia of bioactives" will be found.

"We've been talking to a company in Australia that specialises in assays to prospect or scan for bioactive molecules and it looks like we will be forming a relationship with them. And once a bioactive has been identified we will work with them to take it to commercialisation."

Another of the Riddet Centre's research projects, "Mining Australian biodiversity – a genomics/proteomics approach to milk-derived bioactives", may, in a quirky twist, see platypus milk shipped across the Tasman.

Placental mammals, such as people, give birth to well-developed young. By contrast, the newborn of marsupials and monotremes (think kangaroos, wallabies and possums in one case; platypus and echidna in the other) are tiny and rudimentary. A newborn wallaby is around the size of a jellybean.

In a way you can think of a newly born wallaby as an external foetus. Instead of happening in the womb, most of the joey's development will take place in the mother's pouch or 'marsupium' as it suckles at the teat.

This means that whatever development signals travel down the umbilical cord in mammals must be passed through the mother's milk in marsupials, and herein lies a huge opportunity for bioprospecting.

If the molecules that govern development in the marsupial milk can be identified, then it ought to be possible to identify those same molecules in cow's milk and the genes that are responsible for them. Funded by the Geoffrey Gardiner Dairy Foundation of Australia, the research will be led by Riddet Centre Principal Professor David Mellor and Professor Paul Moughan and conducted in collaboration with the University of Melbourne. "It's an excellent group there, led by a top-rate biologist, Kevin Nicholas, a genomics, proteomics expert," says Professor Moughan.

First, the team plan to identify the stages in development of the digestive tract in the tammar wallaby very precisely. They will then calibrate this against milk samples taken at different stages of lactation. If a stage is particularly interesting, the milk samples will be analysed. "We'll do a complete chemical characterisation of that milk, particularly looking for bioactives that influence development," says Professor Moughan.

If a bioactive protein or peptide is found, then the gene that produces it will be identified. "And then we will go looking for the gene in the cow, and hopefully find a gene that expresses the same or a similar protein or peptide."

"Now you might say, 'Why not go looking in the cow straight away?' But that would be to look for a needle in haystack. Those proteins and peptides will be there, but they will be there in very small quantities."

As it proceeds, the project will involve a variety of strange milk samples crossing the Tasman. Not just tammar wallaby milk, but also platypus and echidna milk, and even (deviating back to a placental mammal) seal milk – which it is thought may have interesting antimicrobial qualities.

The prospect of a new generation of functional foods with only-to-be-guessed-at qualities beckons. Milk must be full of useful yet-to-be-discovered bioactive compounds, if only they could be identified.

As for what lies on the research horizon, Professor Moughan predicts that nutrigenomics – the study of our nutrients' impact on genes to cause specific conditions – is going to be huge over the next 10 to 20 years.

"No two people are the same, and it's not just that they have different genetic propensities for disease development, but also that the foods we eat will turn genes on and off in different ways in different people. So there's the interaction between the genome, which is unique, and the environment, which includes nutrition, and that nutrigenomic interaction. We know very little about it."

Professor Moughan's time is in demand: he holds two company directorships, including the prestigious Geoffrey Gardiner Foundation in Melbourne, Australia, sits on four editorial boards for international scientific journals and is an expert advisor to the FAO/WHO/UNU on dietary amino acid recommendations and protein quality for humans.

His has been a conspicuously successful career, one that has been noticed. "Yes," says Professor Moughan, "in the last couple of years I've been sought to lead a Canadian University and I was recently head-hunted for a prestigious Australian Federation Fellowship. But I like Massey. I have always admired the University for its research ethos and that real hands-on approach which ensures relevance. And while it may sound a bit earnest to say so, ultimately, I'm a New Zealander: I want to serve my own country."

Nick Roskruge and newly harvested taewa.

A tale of taewa

Compared to the potatoes you are best familiar with, Māori potatoes – or taewa – are often small, oddly shaped and colourful. But don't dismiss them for that. Although taewa are unlikely to ever turn up as raw material for McDonald's fries, their history and cultural significance make them a marketable commodity.

"I was really struck the last time I flew into New Zealand. We were handed out a snack – extruded cassava from the islands – and on the back was a little story about the origins of cassava and its indigenous significance," says Professor Moughan. "So why not a product that has that New Zealand indigenous aspect to it?"

Realising the economic potential of taewa is the aim of a research project that has received $700,000 in funding from the Foundation for Research, Science and Technology.

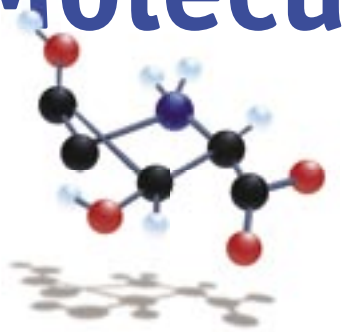
The initial study will evaluate the physico-chemical properties of the various varieties of taewa. Longer term the aim is to develop high-value food products.

Taewa vary widely in their colour, texture, taste and flavour: differences that arise from underlying chemical and physical properties, such as starch and protein content. Before taewa can become an export product, these properties need to be understood.

The Riddet Centre will be working alongside the Tahuri Whenua – the Māori Vegetable Growers Collective.

Nick Roskruge, from the Institute of Natural Resources, and Dr Owen McCarthy, from the Institute of Food, Nutrition and Human Health, will lead the project, along with PhD student Zirsha Wharemate.

Molecules made to order



Organic superglues, disease treatments and better food flavourings: these are some of the projects where synthetic organic chemist Carol Taylor employs her skills.

Carol Taylor calls herself an "architect, engineer and builder". The Associate Professor of Chemistry designs and makes molecules, which she hopes will ultimately enable others to make advances in treating diseases and developing new surgical products.

Providing the "atomic infrastructure" is the speciality of Dr Taylor's seven-strong team.

"A lot of biologists and biochemists are full of ideas but they can't get their hands on the molecules to answer the really interesting questions. What we can contribute is the ability to make things, and I love making things," Dr Taylor says.

She does this from her fourth-floor office at the Institute of Fundamental Sciences. Dressed in jeans and sneakers, surrounded by books and papers, the diminutive chemist explains that once planning is complete sitting at a computer, she'll front up in the lab to make the new molecules, step-by-step, tracking changes using spectroscopy of various kinds.

"Instruments like the nuclear magnetic resonance (NMR) spectrometer can give us enough information on an atomic level so we can know, for example, if we've replaced a hydrogen atom with an oxygen.

"It's an area of chemistry that's more art than most. It's art and science."

The research group has three major projects under way, all focusing on design, synthesis and evaluation of molecules.

Lead-in work was inspired by a sticky protein excreted by blue mussels. Researchers in the USA had determined the amino acid composition of the molecule. The substance, which sticks the mollusc to rocks remains sticky while under water, lending potential for development as "surgical superglue", Dr Taylor says.

"We've made small versions of the sticky protein but what I have to do now is make it more efficiently and produce a reasonable amount of it so we can do something meaningful with it.

"During the mussel protein work we developed skills in the synthesis of amino acids called hydroxyprolines, and this led us almost inevitably to look at collagens, a family of proteins with all sorts of structural roles – they make up skin, cartilage, nails, hair and bone."

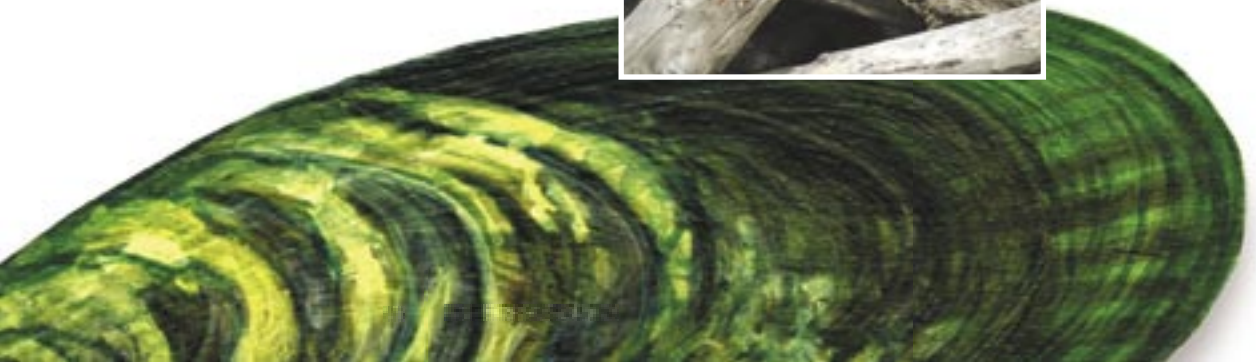
Collagen can be compared to a piece of rope made up of three strands, intertwined to form a tough fibre. Dr Taylor's team is looking specifically at the role of hydroxylated prolines and their derivatives, which are found in abundance in the collagens.

"The challenge at a fundamental scientific level is to understand how the amino acid composition translates to the function of the molecules; for example, what makes them very strong or what happens if there is too much carbohydrate?"

The molecules produced in the study, and physical data, will provide a clearer picture of the factors influencing the structure and stability of these proteins, Dr Taylor says.

"And when we start to achieve that, we may even glean insight into the molecular basis of some collagen-related diseases, including arthritis and osteoporosis. If we can understand what's going on, scientists are then in a position to try and develop therapies."

Some members of Taylor's team have recently become part of a subcontracted project with the Fonterra Research Corporation on a Foundation for Research, Science and Technology project worth



$570,000 over three years. Initially concentrating on cheese, the team is working on novel flavour compounds that may be used in the food industry.

In 2000, when Taylor moved to Massey University, she received Health Research Council funding of $340,000 over three years to look at the design and synthesis of molecules that might have an impact on diseases, including multiple sclerosis and asthma. This work is in collaboration with the University of Auckland's Geoffrey Krissansen.

Dr Taylor graduated MSc at the University of Auckland in 1988, having worked with Professor Con Cambie. She used a compound isolated from the native silver pine to produce a molecule of interest to the perfumery industry.

The fascination with organic chemistry grew through two summers (1987 and 1988) investigating the addition reactions of some bright orange compounds with Professor Harold W. Heine of Bucknell University in the US, and continued with a PhD in 1993 from the University of Pennsylvania and a doctoral thesis involving the development of catalytic antibodies for peptide bond formation under Professors Ralph Hirschmann and Amos Smith. During 1993 and 1994 Dr Taylor was a research associate at Princeton University in New Jersey, returning to New Zealand in 1995 to a position at the University of Auckland, which involved split teaching responsibilities between the Department of Chemistry and Auckland Medical School.

"That was supposed to be 75:25 but I used to joke it was 90:40," she says.

Promoted to Associate Professor last year, she combines her research work with teaching.

"Traditionally people talk about an academic position as being 40 percent teaching, 40 percent research and 20 percent admin, but I think the way things are going in New Zealand you are encouraged to excel at one of these things. You have people who do no teaching … but have other people who do very little research and are committed to teaching. Then there's those of us who are a bit deluded and try to do everything."

Dr Taylor's first academic term this year is immersed in teaching, and she's considering what 'whiz-bang' sideshows she can come up with to capture students who are not chemistry majors. She's also juggling managing her team, securing research funds, organising international placements, and scheduling requests from international bodies who have invited her to speak. Last year she did a six-city lecture tour of British universities, ending in Edinburgh, and this year she'll speak at the prestigious Gordon Research Conference on Natural Products Chemistry in New Hampshire in July, then later in the year in Philadelphia at a symposium to honour one of her mentors.

"I have turned down other opportunities to speak because my teaching schedule doesn't allow it, and I don't have an army of 20 people working for me. I need to spend time at home in Palmerston North working in the lab to produce results.

"And I am still teaching because I think students deserve to be taught by research-active people. That's what a university is supposed to be about."

Though her research team is small, Dr Taylor prefers it that way. "Because it's hard to organise people's contracts, struggle with management and administration. No one teaches you to be a teacher, manager or accountant.

"And I like to keep a pretty close eye on the accounts. We work so hard to get research money and I personally feel a huge amount of accountability to those funding agencies that invest in us – so we try to spend the money wisely."

The scientific community and university structure at Massey are incredibly supportive, Dr Taylor says, and it is "not impossible" to do really good scientific work in New Zealand.

"But it's hard to get good people … One of the biggest problems is getting PhD students because there are too many good opportunities for them to go overseas."

The team is currently composed of two postdoctoral researchers, two PhD students and a visiting student from Germany, with a PhD studentship and research assistant position Dr Taylor is trying to fill. The future looks financially assured thanks to a new Marsden grant of $585,000 over three years confirmed in September 2003. The project is looking at "molecular complexity beyond the genome", in particular how proteins are modified and manipulated during and after their assembly under genetic control.

"We hear a lot about genomics and we can clone the gene and we can manipulate the gene but where's the other information? Getting the DNA doesn't tell us everything. There's the influence of the environmental conditions – the health of the individual, for example."

A focus of this work is an unusual amino acid called histidinoalanine. This is an example of a protein cross-link, in which two previously distant pieces are joined together in an irreversible manner.

"The formation of this cross-link is implicated in the ageing process," Dr Taylor says. "Older teeth, for example, have higher levels, and they also occur in cataracts."

The 37-year-old was presented in 2001 with the prestigious Easterfield Medal, awarded every two years by the New Zealand Institute of Chemistry and the Royal Society (London) to a New Zealand scientist who has made a substantial contribution to chemistry research.

Eighteen years into her chemistry career, she's as enthusiastic as ever.

"Actually making molecules is not a sit on your bum and stare at your computer screen kind of science. It's get into the lab and find a way to make things work.

"The thrill when you do find something is tremendous. A really good 'Eureka moment' only happens every five or six years in my experience, but it's really, really satisfying. To have an idea and see it through to completion is unbelievably rewarding."

The process requires "real creativity", Dr Taylor says with an obvious passion.

"It's the only game in town; it doesn't matter how tired you are or how frustrated you are. It's like a calling. It feels like what you have got to do."

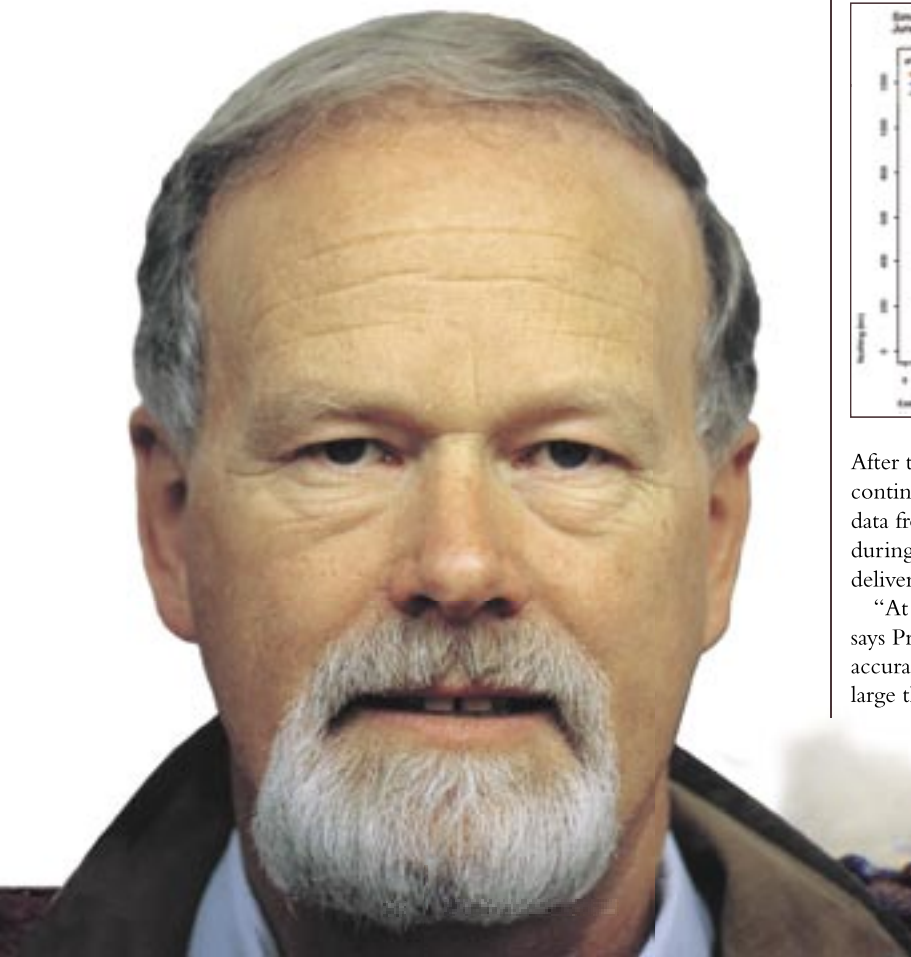
Postscript: Dr Taylor's latest Marsden-funded project entitled *Sweet Nothings: Molecular Complexity Beyond the Grasp of the Genome* will help explicate what happens to proteins after they have been expressed by RNA. An overriding theme is the attachment of sugars, a process called glycosylation. An allied theme is a cross-linking process that appears to correlate with the process of ageing.

This article originally appeared in MASSEY *magazine.*

Battling infection

g infection Battling infecti ttl in cti B ttli e i Battling infection Battling infection Battling infection Battling infection Battling infection

Professor Roger Morris and the EpiCentre are best known for their role in helping Britain battle foot-and-mouth. But foot and mouth is just one of the array of diseases they are up against. And at least one is a strong candidate for becoming a highly infectious and deadly disease of man.

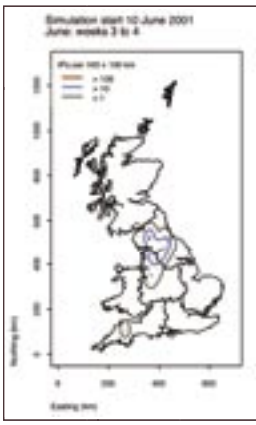


Around mid-morning on Monday 19 February 2001 Craig Kirby, the resident vet at Cheale's abattoir in Essex, was called to look at a batch of sows held over from Friday's shift. Kirby quickly realised he had a serious problem. It must be either swine vesicular disease or foot-and-mouth, he supposed. Either would be bad – both are notifiable – but Kirby assumed, optimistically, it was swine vesicular disease. In this he was mistaken.

After a 30-year absence, foot-and-mouth disease had returned to Britain. At that moment the virus was incubating in almost 40 locations across the nation. Horrors lay ahead: more than four million animals would be slaughtered, thousands of farmers would lose their livelihood, the countryside would become a no-go zone, and tourism would be devastated.

The last infected animal would not be slaughtered until 30 September 2001, and Britain would not regain its FMD-free status until 15 January 2002.

Professor Roger Morris, the Director of Massey's EpiCentre, became involved immediately. Within days of the first diagnosis an invited team from the EpiCentre, MAF and AgriQuality were ensconced in Whitehall – the first team from outside Britain to arrive. Working rapidly with their British colleagues they began preparing a digital map of every British farm and the stock held on it. With the map entered into the EpiMAN software program, they started mapping the progress of the disease. EpiMAN's analytical tools and computer models allowed them to predict the geographical spread of the epidemic and its expected size, both nationally and at more local levels.



A contour plot shows the location of farm holdings predicted to become infected with foot-and-mouth disease during the later part of June 2001.

After the team returned to New Zealand three weeks later, they continued to run analyses. At the end of each British working day the data from the epidemic was sent through to Massey to be processed during the New Zealand working day in time for the results to be delivered back to London before the British breakfast.

"At one stage a colleague was calling it our astrological model," says Professor Morris, "because its predictions were proving so accurate in predicting where the disease would spread, and how large the local outbreaks would be. We modelled the disease, and

the disease behaved almost exactly as we modelled it. Late in the epidemic the model became more optimistic than the real situation, and we were able to show what had gone wrong in the field and what actions were needed to correct the situation."

In the time since the end of the British foot-and-mouth epidemic there has been plenty to keep the epidemiologists busy. BSE, though now disappearing in Britain and most of Western Europe, rumbles on into other areas: Eastern Europe, North America, Japan – and Professor Morris is predicting that several more countries will be affected in the next few years. SARS has appeared out of animals, flared, caused panic, quite rapidly been brought under control, and returned to quiescence. And at the beginning of 2004, the highly pathogenic avian flu H5N1 killed millions of chickens in Asia and – far more ominously – a number of people.

These are just some of the diseases in the animal epidemiologist's Pandora's box. Many of the new diseases which appear around the world, such as AIDS and SARS, are believed to have crossed over from wildlife, due to increasing contact between wild animals, people and their domestic stock as a result of increasing human population pressure. When a disease first establishes in a new species, what may have been an inapparent infection in the normal host can become a very serious disease in the new host, and spread from there to other species.

From his Palmerston North home, close by the banks of the Manawatu River, Professor Morris is attuned to the state of the world's animal health, beginning his day at 5.30 in the morning and closing it at 11.00 at night with a volley of e-mails. It is a day arranged to suit the convenience of his Northern Hemisphere correspondents, but the early mornings seem to suit him. When I meet him he is freshly returned from a meeting about City Council elections – Professor Morris heads the Palmerston North Residents Association – and anything but fatigued. He speaks with verve. "You must direct me," he tells me, aware of the fascination his discipline holds and the need to limit discussion to a few diseases.

I am lucky to catch up with him. By rights, Professor Morris should now be in Europe, but happenstance has meant that a series of seminars on BSE planned for London will now be held in Palmerston North.

Nonetheless, in the next month he will visit such places as London, Hong Kong, Berne, Geneva, Rome and Buenos Aires. In Hong Kong he has scientific collaborators working on avian flu. In Berne the EpiCentre maintains a full-time software developer working with the Swiss government. In South America he will advise a group of six countries and present talks on epidemiology in Spanish, while colleague Dr Mark Stevenson will deliver a workshop on the geographical analysis of disease patterns. In Geneva he will have discussions with the World Health Organisation, then in Rome he will be at a planning meeting on how to monitor bird flu in Asia.

So much in demand is Professor Morris that he has, in effect, cloned himself. He has forgone most of his Massey salary, instead deriving his income from consultancy. The salary saved has gone towards the employment of senior lecturer Cord Heuer, freeing Professor Morris from much of his teaching duties.

When Professor Morris graduated as a vet from Sydney University in 1965, epidemiology – the study of the patterns of diseases and how to control them – scarcely existed as a separate discipline. "I wanted to go to the US and get a PhD in epidemiology and there was only one university offering it – I never did get there," says Professor Morris. Instead he gained the multidisciplinary grounding that would serve him so well by combining full-time work as a field vet with papers: pure mathematics, statistics, economics and ecological systems analysis.

The new graduate was immediately accepted into a teaching position. "This was quite unusual," says Professor Morris. "But I was effectively working in a veterinary practice for the first 11 years, while teaching veterinary students at the University of Melbourne.

"I'd go out and calve a cow in the morning and then rush off to a maths lecture, and then back to calve the next cow, out of the overalls like Superman. So I mixed economics, mathematics and clinical practice for several years while I was developing expertise in running a research programme."

Professor Morris later got his PhD from Reading University in Britain with a thesis on the use of epidemiological and economic studies of animal diseases. He spent time as Assistant Chief Veterinary Officer of Australia, then as a Department Head at the University of Minnesota in the US.

The promise of a chair, funded by pharmaceutical company Schering-Plough, which would be free of the administrative chores of running a department, lured Professor Morris to Massey in 1986. (Schering-Plough, which had initially promised five years' funding, remains a major benefactor.) Nineteen years on, and the EpiCentre has grown from three people to between 60 and 70, around half of them postgraduate students. Not all students are resident at the centre. "About half come in for intensive sessions and then go back to their home bases, which could be anywhere from Hong Kong, to Botswana, to Palmerston North. And the other half are doing research on a wide range of projects concerning diseases in New Zealand and other countries," says Professor Morris.

Among a host of projects, the EpiCentre is working on rabies control in Asia, the global eradication of rinderpest, TB in wildlife in New Zealand, the health problems of race horses, and wildlife disease surveillance – both to protect native fauna and to detect diseases coming into New Zealand through wildlife.

The BSE workshops to be held in Palmerston North are the culmination of 18 months' work by the EpiCentre for the European Commission in Brussels, says Professor Morris. The Commission's problem was that although it has had an extensive and expensive testing programme for cattle, it has been difficult to interpret the results or arrive at a figure for how cost-effective the testing is.

Assessing the incidence of BSE is not easy, explains Professor Morris. Among other complications, the disease has a long incubation period, the likelihood of finding infection depends in part on the age of the animals, and the testing can only be performed on dead animals.

"Some die on the farm, some are slaughtered in abattoirs," explains Professor Morris. "All are biased samples of the source population that are still living on farms, so you need to work backwards to work out how much BSE remains in the cattle population.

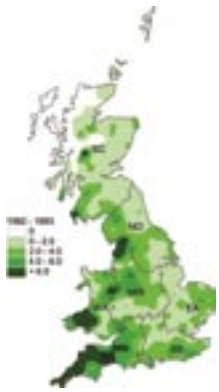


Image plot showing the incidence of BSE across Great Britain (expressed as the number of confirmed cases of BSE per 100 adult cattle per square kilo-metre) for the 12 month period from 1 July 1992 to 30 June 1993.

"We've been developing what we call risk-based surveillance, where you relate the monitoring to the scale and nature of the risk." Professor Morris's method also provides the actual value of the tests: how much information you get per Euro spent. He sees the method as having wide application beyond BSE.

"I am proud of the work our team has done on this. It is quite a breakthrough in how you monitor diseases," he says.

Having come up with the method, Professor Morris has had to negotiate the daunting politics of having it accepted. First it had to be reviewed and approved by the European Commission – as has now happened. Now the method is with the European Food Safety Agency for approval. Finally it must be given the imprimatur of the World Animal Health Organization in Paris.

Another of Professor Morris's projects in Europe is developing a national animal health information system for the Swiss Government. "They are putting about $5 or $6 million into the development with us as the provider," says Professor Morris, who for the past three years has had a software developer based in Berne, and others working on the project in the EpiCentre.

"We have weekly teleconferences," says Professor Morris. And we fly back and forth. Next week we've got one of the Swiss team flying in to work with us for the next six weeks."

When the software is released in early 2005 the Swiss will have the right to use it inside Switzerland and the EpiCentre will own the international marketing rights. Professor Morris is showing the software to other countries, and believes it could be used for human diseases as well. Software packages like this and its famous sibling EpiMAN, which was used during the foot-and-mouth epidemic, take findings from EpiCentre research and put them into practical operation, says Professor Morris.

The EpiCentre's software development has many spin-offs. It benefits the EpiCentre's overall research, teaching and consultancy work and it sells the centre's expertise. "Our software has led to many of the centre's major contracts," says Professor Morris.

Massey has now set up a company to market the EpiCentre's software. "We need a commercial focus and specialist skills to build on the opportunities," says Professor Morris. "We will then concentrate on the research and development aspects."

BSE, SARS, Ebola. . . Why do we seem to be seeing so many new diseases or variations on existing diseases?

The subject fascinates Professor Morris. There are, he says, a number of factors, among them climate change, land use, human practices, and the mobility of people and products.

Many diseases that were once restricted in range are now becoming global issues, he says. He instances West Nile virus – a mosquito-borne virus found in Africa, West Asia and the Middle East, that appeared on the east coast of the United States in 1999 and has now spread across the entire continental US, and into Canada and Mexico.

Of the emerging diseases, most, he says, hail originally from Africa or Asia. AIDS and Ebola are viruses that originated in Africa. SARS and avian influenza come out of Asia. These regions share characteristics in common. "It has to do with the variety of animal species, the extensive interaction between wild animals and human populations, and the high density of human population.

"Take SARS, avian influenza and West Nile virus: these are all animal-derived infections that are getting into new hosts and new physical environments because of human practices.

"I suspect SARS has been occurring in limited areas of China for centuries. But it was a rare and unexplained condition, and you didn't get an explosive epidemic. But then the virus got into Hong Kong, and from there it travelled around the world on aircraft in a very short time."

There are new diseases which can spread from animals to man being discovered from time to time in many parts of the world, such as Lyme disease in North America and bat-derived infections in Australia. But Professor Morris believes that Asia and Africa have the riskiest combination of factors and will continue to throw up surprises.

Among emergent diseases, the nastiest 'surprise' could be a killer influenza virus. Influenza has a history of causing global pandemics at unpredictable frequencies: the 1918–19 'Spanish flu' killed between 20 and 50 million people worldwide – far more than were killed in the First World War – and the 1957–58 'Asian flu' and the 1968–69 Hong Kong flu killed many tens if not hundreds of thousands of people.

The influenza viruses, explains Professor Morris, are native to waterfowl, for which they generally cause few or no problems. But if a virus jumps species it can become highly pathogenic. Avian flu is a natural infection of waterfowl, where it causes no problems, but it can kill large numbers of domestic poultry if infection is transferred from the water birds. New strains of flu are constantly arising, and occasionally one of these has the right combination of features to cause a major problem. The viral subtype H5N1 first hit the headlines when it caused serious human disease in Hong Kong in 1997. Until this 1997 incident it was not considered that true avian flu viruses could cause serious disease in man without first recombining with a human virus in a species such as the pig.

But the H5N1 virus broke that rule, and now epidemiologists must deal with the possibility that one of the avian flu viruses could start the next human pandemic, which in our highly interconnected world would be more difficult to stop than the 1918 pandemic.

For several years the H5N1 virus was found only in China and Hong Kong. But then in late 2003 and early 2004 it was suddenly found causing high mortality in chickens across a range of countries in Asia. By January 2004 in Vietnam alone around one million birds had died from the virus. Nor was the prognosis much better for those people who caught it. Of the 23 cases reported in Vietnam, 16 of the victims died. The average age was 16.

The speed of H5N1's spread was astonishing. Within months it was in places as far flung as Indonesia, Korea and Japan.

H5N1's saving grace is that unlike the 1918 influenza it has not yet generally come by the ability to travel from person to person. The people who have caught it had come in contact with chickens or chicken meat. (A case of transmission from daughter to mother had been reported at time of going to print.)

Could this change? Quite conceivably. H5N1, like all of the influenza viruses, is an RNA virus, and RNA viruses, because of the way they replicate, are constantly mutating. In addition, because the influenza viruses infect a range of species, it is also possible for a new virus to be created that combines the genetic material from the viruses of two or more different host species.

As little as one or two amino acid differences might be all it takes to allow H5N1 to be transmitted, like the common cold, via a cough or a sneeze.

"Then you might have the equivalent of the 1918 epidemic," says Professor Morris.

In a worst-case scenario the killer influenza might be spread by migratory birds as well as by people.

Professor Morris suspects that in Asia many more people catch avian influenza than are ever diagnosed with it. But these are populations that have been exposed to chickens and their illnesses since childhood and have acquired some degree of immunity. The developed world would have no such protection.

All of this makes what goes on in the villages, chicken farms and piggeries of Asia of intense interest to epidemiologists internationally. When an epidemic breaks out it needs to be quickly brought under control. In a place like Vietnam, where there are 160 million chickens and 60 million ducks, and 95 percent of farms have fewer than 50 birds, this is very difficult.

The EpiCentre working on the control of avian influenza in collaboration with the University of Hong Kong and St Judes hospital in Memphis. The centre has recently had two people working in Vietnam, and one of the centre's PhD students is now writing her thesis based on her field work in Hong Kong.

And what of New Zealand? We too have had our problems. In 2000 varroa mite was discovered among beehives in South Auckland and in 2003 PMWS (Post-weaning Multi-systemic Wasting Syndrome) was identified in a New Zealand piggery (also in South Auckland) and diagnosed by one of the EpiCentre's staff.

Internationally, PMWS was discovered in the early 1990s, confirmed as a new disease in the mid-'90s, and has gradually spread to every pig-raising country of significance in the world, says Professor Morris. The sole exceptions were Australia and – until recently – New Zealand.

As was the case with Britain's foot-and-mouth epidemic, the culprit for the introduction was probably infected imported material. PMWS-infected material probably entered the food chain as pig swill around 1999.

"We used to have measures to prevent animal products being fed to animals without being cooked to kill viruses, but in 1998 the controls over feeding human food material to pigs lapsed. At the time we were importing pig meat from a number of countries, and although concerns about PMWS were being discussed there was never agreement on control measures," says Professor Morris.

Currently PMWS has been contained within a small cluster of farms in the Auckland area, directly or indirectly associated with pigs having been fed byproducts and waste products from the human food chain.

"We have low pig densities and the producers who have been affected by this outbreak are outside the mainstream of the industry," says Professor Morris. "So we have been lucky. As far as we can tell there have been no new cases since we introduced control measures – we caught it just before it spread more widely. In Britain and Denmark it also started small, but then it spread rapidly throughout both countries." Now Professor Morris hopes to see the disease, which has ruined a number of pig producers and severely affected the productivity of others, controlled and perhaps eradicated.

If there are lessons we in New Zealand can learn from the overseas experience of animal diseases, then they are the importance of effective continuing surveillance to achieve early detection and control, says Professor Morris. Had foot-and-mouth been detected when it first infected a British piggery, or had a ban on stock movements been instituted the day the disease was detected in an abattoir, the epidemic would never have assumed the proportions it did.

"We have a history of late detection of new incursions, yet we need to detect diseases quickly if we are to control or eradicate them," says Professor Morris. "We invest very heavily in border security, particularly for passengers, but most of our diseases come in with products in containers. I believe we need to focus more on the risks of diseases being introduced by trade and wildlife introduction."

Where a disease is detected he wants the response to be rapid and effective. Does the current Biosecurity Act make sufficient provision for this? Not to Professor Morris's satisfaction. He is lobbying for change.

His third concern is making sure New Zealand has the resources to cope with a major incursion, which would certainly mean drawing on international help. "If we had a foot-and-mouth outbreak on the British scale we would simply not have enough people and resources to cope alone."

He speaks of what he knows.

Calibrating evolution's clock

For someone who professes to be indifferent to the allure of the white continent, evolutionary geneticist Professor David Lambert has spent a lot of time in the Antarctic. His first summer season was in 1985, and in recent years he has been a regular visitor to Cape Adair, where he and his team come to collect blood and bone.

The blood is contemporary, taken from present-day Adélie penguins. The bones are those of their ancestors, now embedded deep in the ground and bound in a frozen confection of sand, guano and rocks.

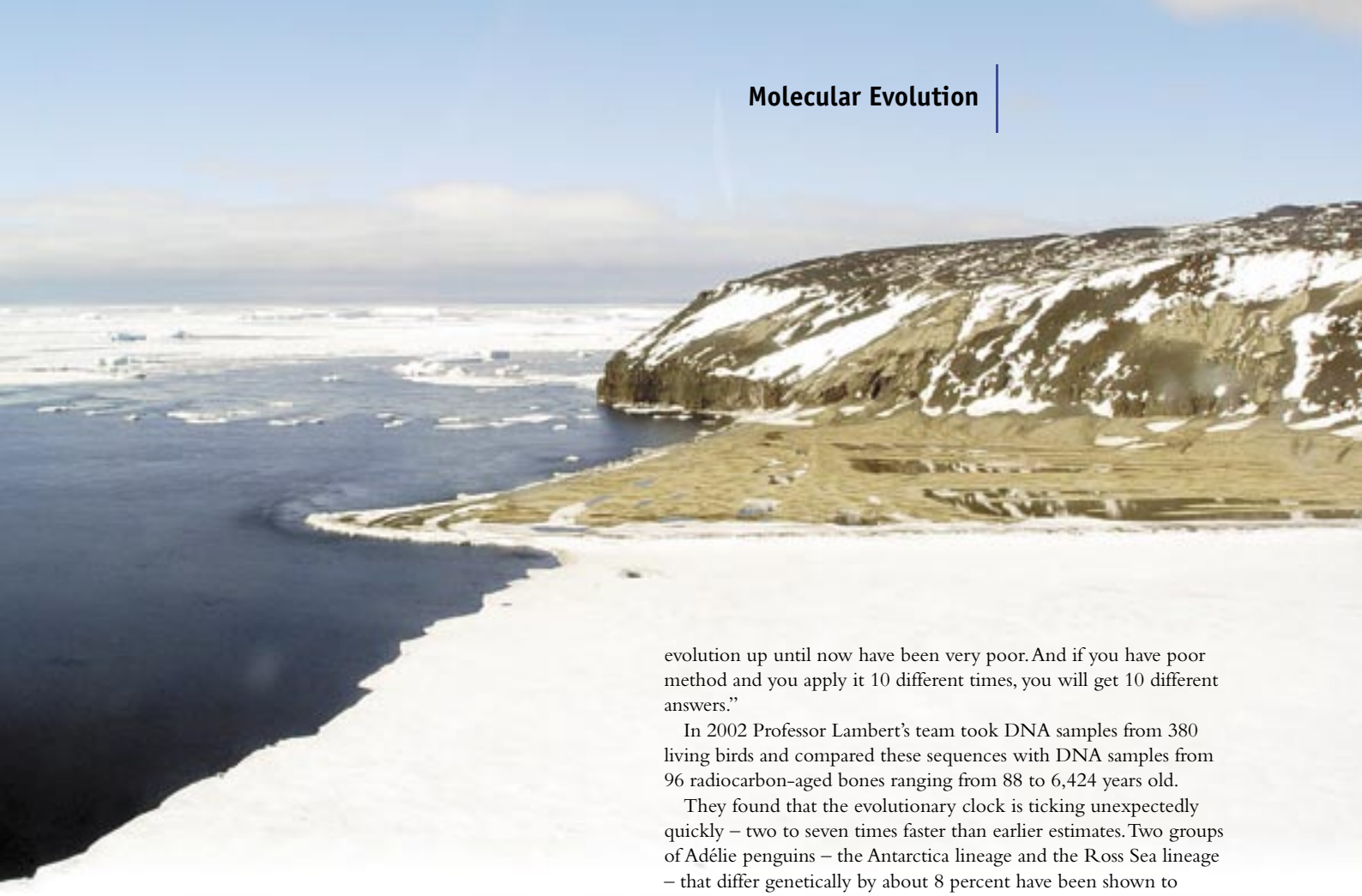
In Professor Lambert's photos Cape Adair has a barren majesty to it, and the penguins an eccentric charm. But neither has much hold on him.

"I don't work on birds because I am interested in birds *per se*, and I don't go to the Antarctic because I am interested in the Antarctic in itself. I work on both of those things because I am interested in rates of evolution. I find that really, really interesting and a much more motivating force than black-and-white birds that walk upright."

Adélies are the emblematic Antarctic penguin. They feature in every Antarctic documentary, are the stars of advertising campaigns, and are the most popular penguins with researchers. Around present-day Antarctica the Adélie population is estimated at 2.5 million pairs. Their colonies occupy islands, beaches and headlands at particular places around the Antarctic coastline. Some colonies of Adélies number in the hundreds of thousands. Year after year the birds return to the same sites, nesting in dense colonies, each nest no more than a shallow depression in the ground lined with carefully chosen pebbles. Here in the rookeries they court, reproduce, defecate – and die. Beneath them the residue of generations – air-dried and deep frozen – can be metres deep and the lowest layers tens of thousands of years old.

The DNA held in this – DNA that can be both dated and sequenced – is the purest pay dirt. For decades, says Professor Lambert, evolutionary biologists have been preoccupied essentially with two things: constructing phylogenetic trees (which resemble genealogical charts) showing how different species are evolutionarily related, and assigning a time scale to them once they have been created. "You want to be able to say that species A and B separated from one another so many thousands of years ago, and that lineage split from the ancestor of species C so many thousands of years earlier than this," says Professor Lambert.

That there should be a way of doing this via what is called the molecular clock is an idea first put forward by Linus Pauling and his colleague Emile Zuckerkandl in the 1960s. The particular clock that interests Professor Lambert is a sequence in the penguin's mitochondrial DNA.



Thanks to Vivien Ward for photography and artwork

Most DNA is not much good for timekeeping. This is because of the garbling effect of sex: the recombination of the mother's and father's DNA. There are, however, two sets of DNA that remain largely intact down the generations: the male Y chromosome and the DNA contained in the cell compartments called mitochondria. Mitochondrial DNA is passed down from mother to child. Your mitochondrial DNA came from your mother, who inherited it from your grandmother, and so forth. The genetic alphabet is restricted to four letters: the bases adenine (A), thymine (T), cytosine (C), and guanine (G). On the odd and infrequent occasion, copying mistakes – or mutations – occur as the genes are passed down through the generations. In one generation a sequence might run ATTCGA and in the next, after a mutation, ACTCGA. A surprising amount of DNA does not code for anything – it is 'junk' – and these mutations can accumulate without consequences for the cell.

So if you know the rate at which mutations accumulate, you can take two sequences of DNA, apply some complex mathematics, and determine when there was a common ancestor. If, it bears repeating, you know the rate at which mutations accumulate.

There have been a number of attempts to find out how fast the molecular clock is ticking. These have centred around taking the DNA from two related species and then going back to the fossil record for a dated common ancestor. But this is a technique fraught with problems: the patchiness of the fossil record, the difficulty of knowing if you have the common ancestor, and the precision of dating, to name just three.

It's hardly remarkable, says Professor Lambert, that using these methods the clock has looked to be running at wildly different speeds. "We think the reason is that the methods for measuring rates of evolution up until now have been very poor. And if you have poor method and you apply it 10 different times, you will get 10 different answers."

In 2002 Professor Lambert's team took DNA samples from 380 living birds and compared these sequences with DNA samples from 96 radiocarbon-aged bones ranging from 88 to 6,424 years old.

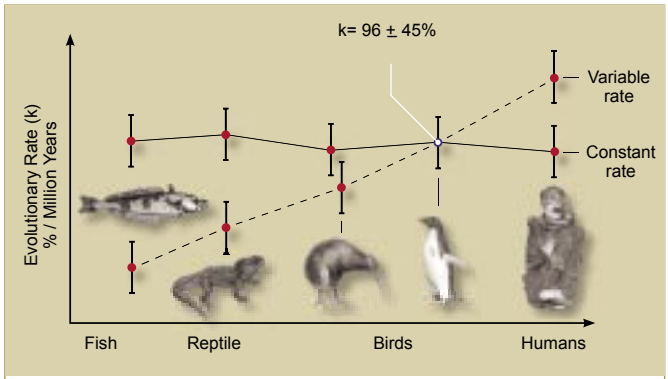
They found that the evolutionary clock is ticking unexpectedly quickly – two to seven times faster than earlier estimates. Two groups of Adélie penguins – the Antarctica lineage and the Ross Sea lineage – that differ genetically by about 8 percent have been shown to have accumulated these differences over 60,000 years rather than the 200,000 years of earlier estimates.

According to Professor Lambert, the 60,000 year mark fits well with the Last Glacial Maximum, a time when there were "few if any, ice-free areas in the Ross Sea, and Adélie penguins were likely to have been restricted to refugia". Isolated from one another by the ice, this was the time for the two Adélie lineages to diverge genetically.

The dating was a landmark event. "This was the first time anyone had measured the rate of evolution using ancient DNA, and the first time anyone had been able to apply confidence intervals to an estimate," says Professor Lambert.

These days Professor Lambert's collection of penguin bones extends back samples that are 37,000 years old, "and we've got DNA sequences from all of them".

But Professor Lambert's results as yet only apply to penguins. Does the speed of the molecular clock vary across species? "People have argued that rates of evolution for the same gene vary a lot in different lineages. My research group has always had the sneaking suspicion that this isn't correct, even though it is the conventional wisdom."



Lambert et al., *Science* 2002

Professor Lambert is also on his way to sorting this out. In a

separate project, he and his collaborators are looking at the rates of molecular evolution in Antarctic fish, kiwi, tuatara and humans. In the case of the Antarctic silverfish, a primary food source for the Antarctic snow petrels, their remains are found in large numbers in the birds' regurgitations, which Professor Lambert has been collecting. Good subfossil records with extractable DNA sequences exist for tuatara and other species. And in looking at the speed of molecular evolution in humans, Professor Lambert's collaborators will, among other things, be drawing on DNA samples taken from an ancient cache of 200 Peruvian mummies and their present-day descendants.

"Do tuatara, for example, evolve more slowly?" asks Professor Lambert. "After all they do everything else more slowly – they grow slowly, they walk slowly, they do everything slowly. Do things like Antarctic fish, which live in very cold environments, evolve more slowly? And do humans and birds, which have high metabolic rates, evolve very quickly? These are the questions our research aims to answer."

Professor Lambert's work with penguins may also redefine, if not solve, one of evolution's great debates: the role of genetic drift versus natural selection.

Natural selection – the survival of the fittest – is a concept familiar to most people; 'natural drift', the other player in evolution, is much less so. Natural selection relies on chance variations that enable an organism to out-survive or out-reproduce its less well-equipped peers.

But not every variation lends an organism an advantage or disadvantage. What happens to these?

When an organism produces eggs or sperm a process called meiosis takes place which halves the number of chromosomes. (Fertilisation restores the full number.) This means that not all of the organism's genes will be represented. Which genes will be represented is determined by chance.

In every succeeding generation chance again has its way. So a gene that was present in 50 percent of the population in one generation, may be present in 48 percent of the next generation, or in 51 percent. In each succeeding generation the luck of the draw happens again – there is no 'genetic memory' of the original distribution. Eventually the gene may be widely distributed or entirely absent in the population.

The suggestion that the vast majority of single-base differences are selectively 'neutral' – and that genetic drift is a major evolutionary force as a consequence – was put forward by the mathematical biologist Motoo Kimura in the late 1960s. The relative importance of natural selection and genetic drift have been vigorously debated ever since.

Now Professor Lambert is in a position to chip in with hard data. "There's a piece of simple mathematics underlying Kimura's argument which argues that for neutral genes the rate of evolution over significant periods of evolutionary time should be precisely equal to the rate of mutation that occurs from one generation to the next. No one has ever been able to test that empirically. We can."

The sequences of ancient and current DNA are providing the rate of evolution. The rate of mutation will be arrived at by comparing the DNA of penguins with that taken from their chicks.

Of course if the rate of evolution does not match the rate of mutation that might mean a number of things, says Professor Lambert.

"It could be that the particular gene you are looking at is not neutral, and there could be natural selection involved, or it might be that it is neutral and Kimura's mathematical model is too simple and abstract to model reality."

Professor Lambert will be more intrigued than dismayed if what he finds only serves to intensify the debate. Questions that spawn answers that give rise to more questions: that, he says, is the nature of science.

The Allan Wilson Centre for Molecular Ecology and Evolution

Professor Lambert's work has been largely enabled by two organisations: Massey's Institute of Molecular Biosciences, and one of the first of the government-funded Centres of Research Excellence, the Allan Wilson Centre, which opened in mid-2002. Hosted by Massey, the CoRE brings together researchers from Massey, Auckland, Victoria, Canterbury and Otago Universities.

The Centre has invested more than $5 million in equipment, including gene sequencers and the parallel supercomputer christened Helix (currently in the process of being upgraded to incorporate the latest 64-bit processors).

Professor David Lambert

Professor Lambert's first degree was in zoology, followed by a master's degree in zoology and genetics. Both were from the University of Queensland. Professor Lambert then wandered the world before becoming fascinated with the work of Professor Hugh Paterson at the University of Witwatersrand in Johannesburg, where he headed to pursue a PhD. (Paterson remains a close friend.) This centred around developing genetic methods to distinguish the species of mosquito that carry malaria from those that don't. His field work took place "in the northern parts of South Africa and in Zimbabwe or Rhodesia, as it was then", says Professor Lambert, who harbours some wistfulness for the days when he counted himself a field biologist rather than a "bench-analytical" one. Then he pauses. He doesn't want to give the impression that what he does isn't fun. It definitely is, and if he could he would persuade more young people to pursue careers like his. "You can go to interesting places, you can work with clever, interesting people like geologists and mathematicians." His, he says, is a wonderful job and with the scientific frontiers lying wide open, this is a wonderful era.

Maths and measles

Associate Professor Mick Roberts has developed powerful mathematical models to predict how

In 1997 a measles epidemic broke out in New Zealand. The number infected quickly rose to about 100 consecutive cases, before a nationwide vaccination campaign instigated by the Ministry of Health kicked in.

The number of cases plateaued around the century mark, then trended down over the next several months. The vaccination campaign was based on the advice of mathematician Mick Roberts, who develops models of infection dynamics.

Dr Roberts, now Associate Professor of Massey University's Institute of Information and Mathematical Sciences, says while a totally successful campaign might have had critics claiming there was no need for vaccinations at all, "the epidemic started before they got their act together, so you could see it start."

Even more dramatic is what the model said about what would have happened if the epidemic was left unchecked – a midwinter peak of more than 9,000 consecutive cases.

"Lots of people didn't get measles because of that campaign," says Dr Roberts.

To develop his model, Dr Roberts and Ministry researcher Dr Martin Tobias studied measles epidemics in New Zealand back to 1962. The equations included historical vaccination rates since immunisation was first introduced in 1969, how many people a child at various ages was likely to come into contact with, seasonal fluctuations in transmission and the basic reproduction ratio.

This latter ratio, which is known as R_0, is the average number of secondary cases generated by a primary case in a fully susceptible population. For measles in New Zealand, R_0 seemed to be 12.8. R_v, which is the average number of secondary cases generated by a primary case after an immunisation campaign, was 2.85. If R_v can be got below 1, a disease can be eliminated.

The values were adjusted until the model matched the historical data between 1970 and the last epidemic in 1991, then the solution was continued until 2000 to predict the future epidemic.

Dr Roberts and Tobias also identified a flaw with the vaccination programme, which was likely to lead to another epidemic about now if the strategy was unchanged. Children were vaccinated at 15 months and again at 11 years. They recommended the second vaccination be brought forward to between three and six years – probably about the start of school for logistical reasons. This change was made in 2000.

"R_0 is now just below 1, but we have to keep up the pressure, especially round the follow-up vaccinations, or we could have epidemics in future," Dr Roberts says.

The importance of predictive modelling was recognised in the official report on the British foot-and-mouth epidemic, which cited three case studies of successful models: the Ross-Macdonald malaria model, a study of fox rabies in France and the New Zealand measles model.

At the time he did the work for the Ministry, Dr Roberts was working for AgResearch on problems such as determining the most effective baiting strategies for eliminating tuberculosis in possums.

"I got into this branch of mathematics by accident," says Dr Roberts. Dr Roberts's first degree was in aeronautical engineering at Bristol University. "Then I worked for BAC on the Concorde back in the early 1970s. I was analysing test flight data, which was really boring, so I got fed up and went to Cranfield Institute of Technology to do a master's degree in applied maths." He followed this with a PhD at Victoria University in the mathematics of fluid dynamics and a position doing mathematical modelling at the Wallaceville Animal Research Centre in Upper Hutt.

"I ended up working on things like hydatids and intestinal parasites in sheep – the things farmers drench for."

Dr Roberts joined Massey in 2003 after 26 years at Wallaceville, but still does contract work for AgResearch.

He continues to help the Ministry of Health with such scenarios as the proper response were there to be a SARS or smallpox outbreak here.

"Compared with previous epidemics, SARS was pretty minor. The Spanish flu at the end of the First World War took 40 million people. That was a decent epidemic in mathematical terms, whereas SARS killed 774," Dr Roberts says.

The SARS work showed how, with a well-constructed model, "you can make surprising progress with relatively little data." Dr Roberts's SARS model included the incidence of infection, the contact rate, the probability of getting infected on contact, and the number of people susceptible. Factor in time and you should get some idea of how fast an infection can spread.

"With SARS, we knew no one was infectious until the fourth day after exposure, and no one was infectious after 14 days. You make some guesses, and as you get better information you revise it."

R_0 for SARS is about 3.3, and the limited infection time means that quarantining people as soon as symptoms occur is an effective way to stop its spread.

As well as working on the mathematics around R_0, Dr Roberts and Professor Hans Heesterbeek of the Faculty of Veterinary Medicine at Utrecht University in Holland have come up with a new method for estimating the effort required to control an infectious disease. "It spun off from a project we did on dengue in Indonesia in 2002," says Dr Roberts.

R_0 isn't particularly useful when describing diseases like dengue and malaria, which have more than one host species, because it is averaged across species. Dr Roberts and Heesterbeek came up with T. "If you have multiple species or types, T allows you to map back on the original species you are interested in."

T could help in the development of control strategies for infections like malaria, bovine tuberculosis, foot and mouth and HIV.

Roberts's team at Massey includes post-doctoral researcher Dr Mini Gosh, who is working with him on the possum tuberculosis project, and PhD student Joanne Mann, who is working on human diseases and vaccination strategies.

Dr Roberts is also working with Dr Geoff Aldis of the Australian Defence Force Academy in Canberra on invasion problems of infectious diseases, and continues to work with Heesterbeek on R_0 and T.

He is also setting up a collaboration with a group at Oxford, who are interested in HIV/AIDs, the co-evolution of viruses and similar problems, and will spend several months at Oxford next year on a visiting fellowship.

Under the volcanoes

The volcanic activity that rocked Mt Ruapehu in the central North Island throughout 1995 and 1996 caused upwards of $130 million in damage and lost productivity. Yet this is as nothing compared to events that have been and events sure to come. Stand on the Desert Road, close by Ruapehu, and you will see layer on layer of ash and charcoal exposed in the road cuttings.

As a part of the Pacific ring of fire, we know that volcanic eruptions will be a part of our future. But at what risk are we, and what would the consequences of an eruption be?

Geologist Dr Shane Cronin heads a team with a membership that spans disciplines and institutions. Funded by a $4.2 million grant from the Foundation for Research, Science and Technology, they are to assess the volcanic risk posed by the North Island's main mountain-building volcanoes, Mounts Ruapehu and Taranaki.

When might Taranaki or Ruapehu erupt again? What would the magnitude of the volcanic event be? What would the economic cost be? These are the sorts of questions they will be answering.

Even a small eruption could be catastrophic. The Taranaki region is home to 20 percent of our dairying industry – 5 percent of New Zealand's GDP is generated by the Fonterra dairy plant in Hawera alone – and is the source of New Zealand's $1.25 billion natural gas supply. And the prevailing westerly winds mean that ash eruptions could completely paralyse air links within the North Island.

"The work we are doing will reduce the risk and costs to these industries from a volcanic eruption hazard," says Dr Cronin. "We will answer the question of whether there is a high risk of a volcanic eruption and how that risk stacks up against other threats to industry. At the moment we don't know the relative importance of an eruption compared to other hazards such as flood or even computer espionage. And because we don't know how big the risk is, we don't know how much to put into protection. The organisations involved want to balance how much money they could put into protection against how much money they could save by having the protection in place if there is a volcanic eruption. Our research will give them information on which to make informed decisions about hazard protection measures. Something they haven't been able to do in the past."

How do you arrive at a percentage chance that there will be a volcanic hazard in a particular time frame and then go on to predict the nature of that hazard and the potential impact it would have? The answer lies in the past.

Until now technology has enabled the measuring of only major eruption events, not the smaller events that have happened over the intervening centuries. "By looking closely at the record of the last 1,000 to 2,000 years of eruptions, we have the best chance to find out the detailed factors controlling the rise of the erupting magmas at andesite (mountain-building) volcanoes. Over this geologically brief time a wide range of different events with strong differences in explosivity and hazard potential occurred. We want to find out why our volcanoes behave in this seemingly irregular fashion. If we can understand these eruption drivers, perhaps we can also develop tests that could be used on ejecta at the beginning of eruptions to give rapid forecasts of what might happen next."

Although the pattern of eruptions over the short term appears chaotic, Dr Cronin believes a pattern will emerge over a longer time span. Whether the pattern will show eruptions as clustered or periodic he is less certain.

Pinpointing exactly where we currently are in the cycle will also be crucial for predicting the future. The present visible mountain that is Mount Taranaki is a mere 10,000 years old, although volcanism has been going on for at least 130,000 years at that location.

"We know very little about this volcano for up to 90 percent of its lifetime. At what stage of life is it now, adolescent, mature or geriatric? Are our volcanoes in a period of decline, or major growth? Investigating long-term changes at these volcanoes will help us predict what they are capable of. From this we should be able to forecast the timing of an event in a probabalistic sense. The more modelling work

we can do, the better we will be at predicting the effect. So if x happens we will be able to predict y – the effect and impact."

The modelling will be performed on a supercomputer owned by the University of Buffalo, which is collaborating on the project. The supercomputer is one of the most powerful in the US outside the military.

Dr Cronin says the data from the 1995/96 lahar flows are providing the University of Buffalo with a real-world scenario to test the accuracy of their modelling. They've fed the measurements taken during and after an initial lahar flow into the programme and then calibrated it to mimic the actual event as closely as possible. The result is a two-dimensional computer-generated re-creation, accurate to five metres, which shows a lahar flowing from the crater lake, down the mountain. It shows where the lahar pools, where it gathers debris, and where it ends up.

It is a topical study; the threat of a lahar from a full Crater Lake is currently very real, says Dr Cronin. In 1953 151 people lost their lives when an express train plunged from the Tangiwai Bridge. The bridge had minutes earlier been fatally weakened by a lahar from Mount Ruapehu.

"With Crater Lake beginning to rise behind a barrier of ash and ice, there's a feeling of déjà-vu. The heightened lahar risk is much like that experienced in 1953."

The difference, he says, is the effort going into the observation and monitoring of the situation. "We will be attempting to learn as much as possible from a possible break-out lahar, but before the event we are trying to use a complex two-dimensional modelling approach to predict the velocity of the maximum-expected flow. Using mathematical codes supplied by our collaborators at the University of Buffalo we will be deriving critical flow parameters to adapt and apply these to modelling the risks of the next lahar flow. We are working under time pressure to have our forecasts ready for the ultimate test!"

When it comes to the volcanoes he studies, Dr Shane Cronin believes in close contact.

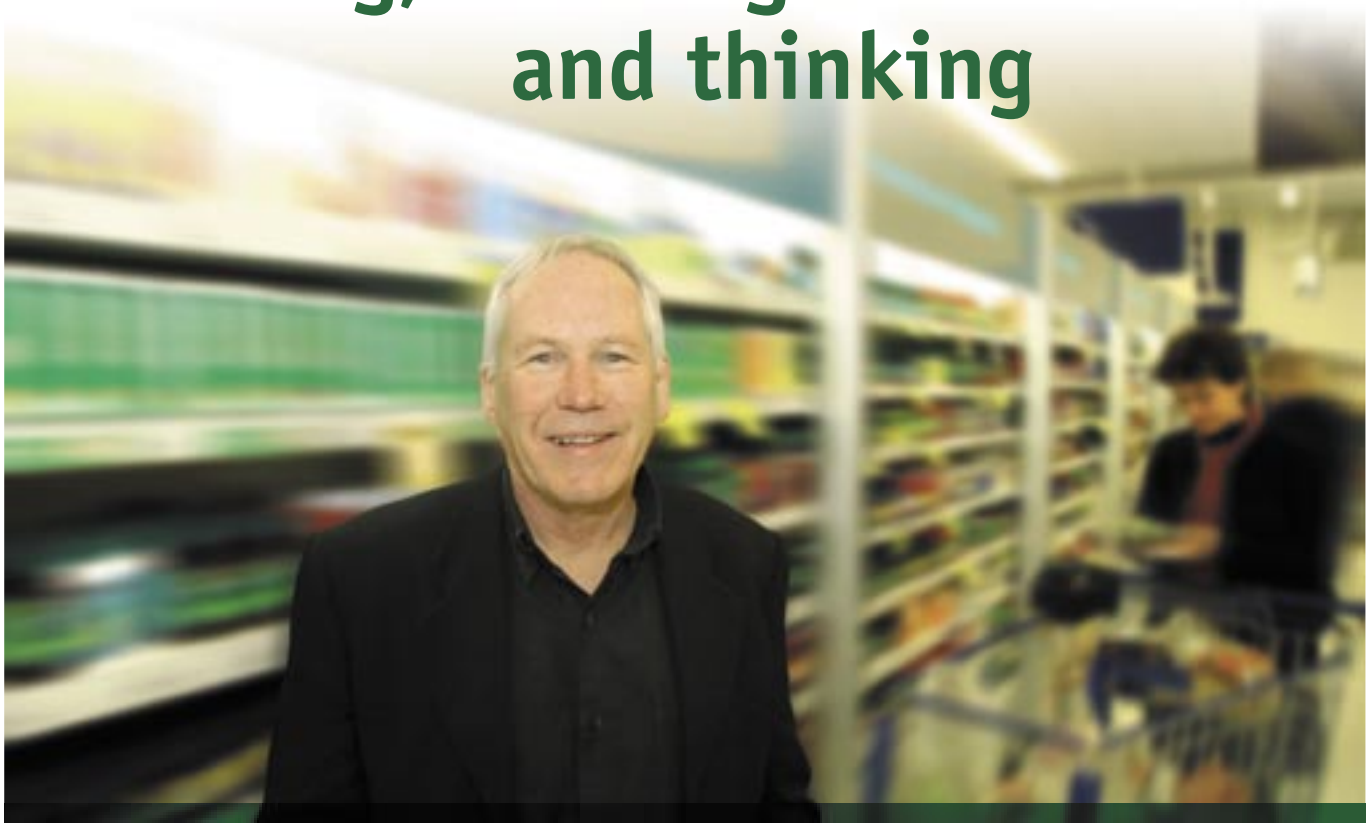
Last year Dr Cronin, a senior lecturer in the Institute of Natural Resources, camped out with his postgraduate students on Vanuatu's volcanic island of Lopevi, monitoring seismic and volcanic activity, locating lava flows using GPS measurements, gathering samples and scrambling around the fresh debris.

This was not Dr Cronin's first visit to Lopevi. He has visited Vanuatu seven times, and has established a nationwide volcanic alert system there, similar to the numerical alert-level system used in New Zealand. Currently he is running a series of UNESCO-funded workshops in Vanuatu teaching people how to respond in times of volcanic activity. (His lessons were put to the test on a recent trip when nearby Lopevi erupted in the middle of one of the workshops.)

Dr Cronin has also led international research teams dealing with volcanic risk management in Fiji, Tonga, Samoa and the Solomon Islands. Up to half of Dr Cronin's research is done offshore,

Dr Cronin has had over 30 articles published in refereed publications. He is an expert member of the International Volcanic Health Hazard Network looking at the risk of over-exposure to fluoride in various parts of the world. He is on the Technical Advisory Group to the South Pacific Applied Geoscience Commission. He belongs to the Geological Society of New Zealand, the New Zealand Soil Science Society, and the International Association of Volcanology and Chemistry of the Earth's Interior.

Eating, drinking and thinking



Kerry Chamberlain is Associate Professor of Psychology at Albany. His research in health psychology aims to identify our everyday understandings of health and the ways in which we try to make sense of them. Dr Chamberlain's current research interests include the examination of people's understanding of medication and how it is represented in the media; the role of the media in health messages and how they are understood; the relationship of food to health; functional foods and the medicalisation of food products; and dietary supplementation and its relation to food and health.

The Chamberlains of Mosgiel were a working-class family with no-nonsense ideas about food. There was a standing order at the butcher's for the weekend leg of hogget and a meal wasn't a real meal without potatoes. Kerry Chamberlain, who now spends a large part of his time thinking, researching, lecturing and writing about food and its place in our culture, laughs when he contemplates the potato in 2004 – about to be demoted from its current position on the FDA food pyramid as a vegetable, to a distinctly less desirable position as a carbohydrate.

These days, says Dr Chamberlain, his father, who comes from the generation that experienced the depression of the 1930s followed by World War II, probably wouldn't recognise much of the food in his son's refrigerator, such has been the change in our dietary habits over the last 50 years.

Apart from being a creative cook, and some years ago helping his partner run a Palmerston North café where the hazelnut chocolate dessert achieved a measure of local fame, his interest in food as a social scientist was sparked during an extended stay in Hong Kong in 1996 where he was Visiting Scholar at the Chinese University. In Hong Kong he observed the "quite elaborate" relationship between food and health in Chinese culture.

Western society has its own version of this relationship. "'An apple a day…' 'Feed a cold, starve a fever' – this is not new. We've been putting iodine in salt for years," he says. But what has become one of Dr Chamberlain's research themes – the medicalisation of food – has accelerated over recent years to the point where he wonders just how we can know what is food, what is a drug and what is a supplement?

The increasing intertwining of food and medicine in contemporary life is due in large part to advances in nutritional and medical science. In a recently published article Dr Chamberlain writes about the phenomenon of 'healthism' – the modern preoccupation with health by governments and lay people, against a political background in which people are encouraged to feel more morally and behaviourally responsible for their own health:

With the rise of neo-liberalism, the creation of the health consumer and the promotion of personal responsibility for health have characterized contemporary health concerns. Food manufacturers and marketers are conscious of this trend …and are constantly developing and promoting new products to take advantage of it. Since food is salient for health and vice versa, it is not surprising that food and health have become intertwined to a considerable degree in contemporary society. [1]

The increasingly complex relationship between food and medicine has, he says, become a site for competing discourses in society. Food is not a simple entity. It can offer health and life but it can also bring illness and death. So people have to make sense of food (and health) in the context of their identities, their social relations and their morality as an eater.

"If we look at food there is a huge range of problematic debates going on – about genetic modification, irradiation, globalisation and the consequent homogenisation of food. There is resistance to this with the 'fresh, natural and organic' food movement. What intrigues me is how people make sense of it? How do you make sense of the

fact that you want your food to be safe, clean and hygienic? What I think is happening to consumers is that the world is becoming quite a lot more complex and difficult for them, and my suspicion is that there is a layering of anxiety about what you should eat, how and when you should eat and so on."

Nutritional science developments have, he says, enabled the separation of food into component nutrients that can be evaluated and constructed as health-promoting (such as fibre and antioxidants), or health threatening (fats and sugars).

"Quite clearly we've learned a lot from medicine and a lot from nutrition. But I have a bit of a gripe with the fact that nutritionists keep talking about 'nutritional material' – they take food apart. Well I don't eat calories, I don't eat proteins, I don't eat fats – I eat ice-cream or pasta or bread or whatever it is. Some people have learned to break things down in their heads."

He describes a recent faculty meeting where some nice chocolate brownies ('bad food') were left over. He purloined one for a co-worker who looked at it with horror and said: "I couldn't possibly eat that – it's eight points!" "At the time I didn't know what she meant. But I was amazed that she could look at a piece of food and give it a number!" He laughs. (Now he does know the difference between a Weight Watchers and a Brownie point).

The creation of the 'health consumer' has meant that we have also created the need for self-surveillance and self-monitoring about our eating and our health. Some of Dr Chamberlain's work with co-researchers has focused on women. Women, he says, are particular targets for marketers of health products. Food and diet are highly gendered, with women still predominantly responsible for choosing and preparing healthy family meals. These can serve to maintain family harmony and symbolise love and nurturing. A recent study involves a discourse analysis of a number of popular women's magazine nutritional health texts as well as looking at women's own experiences of nutritional health.

"We set off with the naïve idea that it would be individually targeted – it would be about being a healthy woman and being a good-looking woman," he says. "And then we found out that quite a lot of it was about feeding your children, which the women saw as their responsibility."

For some of the women, eating as a pleasure was disassociated from 'healthy eating'.

"One of the women talked about buying treats (i.e. 'dietary baddies') and hiding them from the family. She felt okay about doing this, but not okay about her family knowing that she did. What does this tell us about how we're eating?"

And nowhere is the medicalisation of food more obvious than in the controversial area of dietary supplementation. Another recent study Dr Chamberlain was involved in considered the meaning of dietary supplementation to a group of women who routinely take high levels of supplements. The study showed that while the women's dietary supplement use was superficially motivated by practical health benefits and legitimised by scientific understandings, it was ultimately driven by the underlying notion of health as a moral and personal responsibility.

For those who are not actively users of dietary supplements, they are pretty hard to avoid these days.

Says Dr Chamberlain: "I go to the supermarket now and find that the bread is supplemented with vitamins, orange juice is supplemented with vitamins and calcium. We haven't found out yet how to supplement vegetables, but yesterday or the day before I was reading about a group at an American university who've developed a clingfilm that is edible. Not only that, but you don't have to wrap it – it can be sprayed on or the food dipped in it! So you can preserve food – and, wait for it, you can add vitamins to it. This seems to me to be the ultimate product."

Another area where food and medicine have become interconnected is the creation of functional foods or 'neutraceuticals'. These include, for example, margarine that has a cholesterol- reducing additive, promoted with advice on daily dosage, or snack bars aimed at reducing angina pain or preventing hypoglycaemia in diabetic individuals. And of course medicines such as diet pills and drugs can used to control food intake.

So does this all mean we are headed towards food in a capsule?

"Well, yes and no. That's the trouble with questions," he laughs. "You can see food in a capsule now – supermarkets have breakfasts in a box. After exercise, there are electrolytic drinks, scientifically based – nothing so simple as having a drink and an orange, it's: 'Take a bottle of this specially formulated product.' And the functional foods-people are moving strongly into that stuff. The pharmaceutical companies have worked out that they can make x million dollars from regular drugs and sitting on top of that, if they can get going, is x times three or four billion in functional foods. Because the regular drugs you can only sell to people who are sick – but functional foods can be sold to the rest of us.

"But yet nobody is going to give up the pleasure of an Italian meal in a restaurant with six friends to celebrate your birthday are they? Surely we're not going to have six pills arrive on a plate and say: 'Oh God this tastes just like the lasagne my grandmother made…'".

An obvious big-picture thinker, Dr Chamberlain admits that his work these days strains at the borders of sociology.

"Traditionally the relationship between food and health has not been a focus of interest for health psychologists. What research there is tends to promote healthy eating, look at dietary control and generally assumes that we all know what constitutes a healthy diet. It has frequently been overly simplistic."

He sees his role as a researcher in this area as alerting people to the complexities surrounding food rather than making judgements about what is good or bad. To him it's about establishing a broader agenda for health psychology research into food and health. Potentially this research is of use to policy makers. As an example he uses the vexed question of obesity (incidentally 'medicalised' nowadays into an 'epidemic', although it is not actually a medical condition). Highlighting the multi-faceted nature of food and eating will, with luck, discourage simple solutions such as a 'fat tax'.

His use of qualitative methodologies also goes beyond the simple 'cause and effect' answers. "The type of research I am interested in doing doesn't produce predictions; it produces understandings of why things are going on like they are, which then opens the door to possible interventions. At the moment I am still trying to figure out what's going on. I'm just trying to look at how it's all happening. There are no simple solutions – but I would hope maybe some insights and understandings."

Dr Chamberlain himself exudes energy and enthusiasm. He describes his health as good, though the prospect of writing a paper to be delivered the next day in Palmerston North, attending an Ethics Committee meeting later in the week and packing his bags for a conference in Edinburgh has him admitting to a little stress. However you won't catch him taking any anti-stress supplements. Perhaps it's those sturdy Southland origins, but his personal belief is that if you eat broadly and sensibly you don't need dietary supplementation.

[1] Chamberlain, K. (2004). Food and health: Expanding the agenda for health psychology. *Journal of Health Psychology*, Vol 9 (4) 467- 481.

Te Ao Māori

Colleagues and peers speak of Mason Durie as a quiet and pervasive influencer. His commitment to use his knowledge and experience to further Māori development is well known. He rarely passes up an opportunity to make a contribution, inside or outside his specialist sphere of Māori mental health.

He is, for example, part of a unique collaborative project that is trying to predict and influence the future of secondary schooling in New Zealand. The objective is to lift the success rates of students, regardless of their background. The Government-sponsored Secondary Futures – Hoenga Auaha Taiohi group, set up earlier this year, will work with the education community to stimulate thinking on what secondary schooling should be like in 20 years' time and the best ways to improve student outcomes. The project is expected to run for up to six years.

Professor Durie is also a member of the External Reference Group for Te Puni Kōkiri, the Ministry of Māori Development, which is scoping strategic directions for the Ministry. And the medical community also values his input through his work on bodies such as the National Health Committee and the Mental Health Foundation.

When he joined Massey in 1998 to head the new Department of Māori Studies, Mason Durie had spent almost two decades in clinical practice as a psychiatrist and two significant years on the Royal Commission on Social Policy.

Those two years on the Royal Commission, one of the biggest and most controversial research efforts New Zealand has seen, greatly affected the way he approached his job. "For me it was an intensive course in social policy and research into social policy," Professor Durie says. "Although some politicians had a problem with it, the state has used it. Many things, particularly in volume two about the Treaty of Waitangi, are accepted now. It is a valuable resource used by thinking people."

What marked the Royal Commission out from earlier, similar exercises was the effort made to hear from Māori communities.

"I was very much aware at the end of the experience that the way Māori saw social policy and the way Māori were articulating their aspirations for development had a different base and a different reality from what others were saying," says Professor Durie, whose roots are in Rangitane, Ngāti Kauwhata and Ngāti Raukawa.

In his work as a clinician, Professor Durie had already explored the different ways Māori considered their health needs. This interest was influenced in part by his exposure while studying at McGill University in Toronto, Canada, to pioneering work on what was then called 'transcultural psychiatry'.

"When I went to Massey, I built on what I had gained in my understanding of health and what I had gained in the understanding of social policy. I began to look at Māori-centred approaches to research where you put Māori experience, Māori values, Māori aspirations at the middle of your methodology.

You don't say, 'How do I adapt this approach to Māori?'. You start from the premise 'What is important to Māori?' and build around it."

Professor Durie says Massey's research is Māori-centric, rather than comparing Māori and non-Māori. He sees the role of Māori studies departments in universities as being to facilitate research into Māori development in its broadest sense.

At the University he has launched a raft of projects, many reflecting his health background, which are building up an unprecedented amount of empirical data about Māori life and society.

The largest is Te Hoe Nuku Roa, a longitudinal study of 700 Māori households, which is in its eighth year. Every three years researchers visit each of the target households to quiz whānau members on what they do, what they eat, their health condition, their use of Māori language and what it means to be Māori.

Another major project, Te Rau Puawai, is linked to the development of a Māori health workforce; a further study aims to help improve Māori language skills; and studies in collaboration include a major survey of child nutrition and a mental health prevalence survey, working with the World Health Organisation and the University of Auckland.

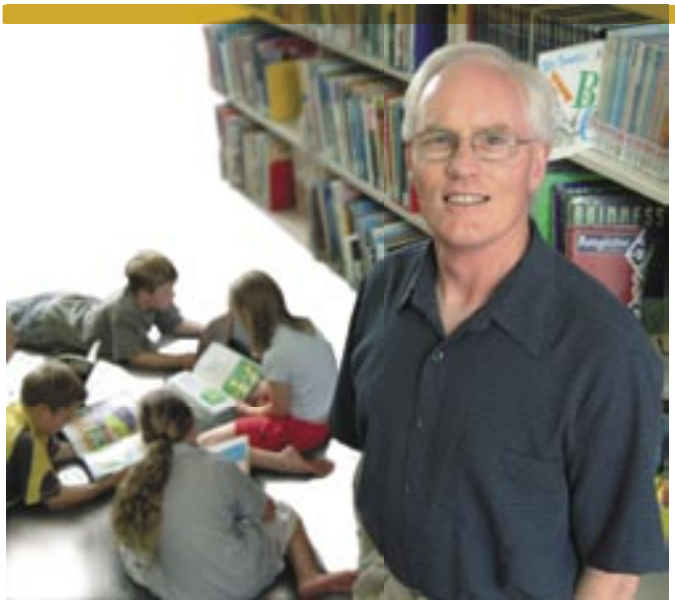
In the past a common complaint of Māori people was that they were over-researched, and many communities were hostile to academics. Professor Durie says now that better methodologies for Māori research have been developed, Māori people are flooding into the field.

The fundamental issue was that researchers were not attuned to the Māori situation, so there was no gelling between researcher and researched.

"If the methodologies you use and the rationales you use are not linked to Māori realities, they are not going to have much impact or be of much use to anyone later on. That is in no way discounting Western methodologies. It is saying, though, that the approach you use needs to have account of the values of the people you are researching."

The research emerging from Massey is now being used for planning by government agencies, local government and iwi rūnanga.

The University has recognised Professor Durie's contribution by appointing him Assistant Vice-Chancellor – Māori, allowing him to retain the role of Professor of Māori Research and Development. Despite new responsibilities, he continues his track record of community involvement and publication. His most recent book, *Launching Māori Futures*, is a collection of keynote addresses covering aspects of Māori development and advancement into the twenty-first century.



Sounding things out

How should we teach children to read? It is an issue that has provoked fierce, sometimes ideologically tinged, debate over the decades, particularly between the proponents of phonics and the 'whole language' approach. If you want to know where the balance should lie, then you could hardly do better than to talk to Professor James Chapman, one of New Zealand's leading education researchers and the Pro Vice-Chancellor of Massey's College of Education.

Since the 1980s Professor Chapman has worked with Professor Bill Tunmer, also of the College of Education, researching how children learn to read and assessing the Reading Recovery programme used in New Zealand schools.

Their research findings support the use of word-based strategies, or phonics, as the principal tool to be used in teaching children to read. The 'whole language' approach currently being taught in New Zealand schools, where children guess unknown words from the context, should be used only as a secondary tool, they say.

"The whole language approach on its own just doesn't work," says Professor Chapman. "Predicting words from context is a highly ineffective and inappropriate learning strategy. Children should be encouraged to look for familiar spelling patterns first and use context to confirm hypotheses about what unfamiliar words might be, based on word-level information."

Another flaw they found with the whole language method is that it makes certain assumptions about a child's pre-school literacy preparation.

"It's a comfortable, middle-class model that assumes basic language skills are in place before the child starts school," says Professor Chapman. "It means Māori, Pacific and poorer children can be disadvantaged because they often do not go to school with the same familiarity with books, reading and 'context'. Our research shows these children respond better to phonics."

"A major problem we found with the theory behind the whole language system is that it claims that reading and writing are acquired 'naturally', in the same way that we learn to speak and listen," Professor Chapman says.

But the Massey professors' research indicates that phonics might be a more 'natural' way for children to learn to read. They found that most children rely primarily on word-level information to identify unfamiliar words, even though they have been told to do otherwise.

Professor Chapman and Professor Tunmer's research into the effectiveness of the Reading Recovery programme used in New Zealand schools has been extensive and controversial.

Reading Recovery was developed in 1985 by whole language advocate Marie Clay to help children having trouble learning to read after a year of formal reading instruction. But where it falls down, says Professor Chapman, is that it provides more of the same type of reading instruction that these children have already failed at.

Their research showed that children selected for Reading Recovery showed major deficiencies in phonological processing skills. But it also showed that Reading Recovery did not eliminate these deficiencies. Even for children considered to have succeeded in the Reading Recovery programme, it failed to significantly improve their literacy development, they found.

Professor Chapman and Professor Tunmer used their research findings as the basis for a submission to a 2003 Select Committee inquiry into the teaching of reading in New Zealand.

Among the 35 recommendations subsequently put forward in the *Report of the Education and Science Select Committee* was one urging that teaching methods for children should include word decoding, including sounding words out.

Professor Chapman has been with the University since 1980, first lecturing in the Faculty of Education, then as head of the Department of Learning and Teaching after the 1997 merger with Palmerston North College of Education.

He was appointed to his current position in 2003.

Professor Chapman's areas of expertise include educational psychology, learning disabilities and special education. He has a long and distinguished international reputation as a scholar in literacy and is a strong supporter of phonics-based literacy teaching.

He is President of the International Association for Research in Learning Disabilities and has published widely in the international literature in literacy, educational psychology and learning disabilities.

Surveys in the dock

Lies, damned lies and questionable surveys. Not all surveys are to be trusted. Professor Janet Hoek can tell you which ones can.

Who has the right to use the name Budweiser? Does it belong exclusively to the American brewery that began making a beer of that name in 1876, or can it be used by, let us say, the Czech brewery, Budejovicky Budvar, to sell its own Budweiser Budvar?

The American brewery knew where it stood. From the 1990s, country by country, it launched a series of suits against Budejovicky Budvar over trademark confusion, and among the evidence it presented in New Zealand was a survey.

Call expert witness Professor Janet Hoek.

In legal cases involving intellectual property or trademarks, the use of surveys has become commonplace. How easily can one trademark be confused with another? A consumer survey should say. However surveys, like witnesses, are not all to be trusted, says Hoek.

And Budweiser's survey was, in Hoek's opinion, a survey not to be relied on: flawed in its methodology, in the wording of its questions, in its design and its administration. The respondents said they had been almost harassed into the 'correct' responses.

"Survey evidence used to be considered hearsay, as the respondents weren't available to be cross-examined," says Hoek.

"The use of surveys seems to be increasing, but a lot of the evidence adduced shouldn't be given much weight because of flaws in the way the surveys have been designed or conducted."

Recently Hoek and her colleague Professor Phil Gendall (who is also often called on as an expert witness) were commissioned by the New Zealand Law Foundation to examine the use of survey evidence in intellectual property litigation. The nearly $40,000 grant will go toward developing a series of guidelines to be used when commissioning and reviewing survey evidence in intellectual property cases.

With Hoek often being called on to critique other people's survey methods, she is very careful with her own.

The direct-to-consumer advertising (DTCA) of prescription drugs is a practice only found in the USA and in New Zealand, where it became legal in 1981. It is DTCA that brings you word of those best-selling products that help you lose weight, control asthma, keep hair, and address problems of a personal nature.

Whether DTCA should be legal is contentious. While drug companies and free market advocates naturally favour DTCA, others are less certain. "One of the arguments about DTCA is that it is promoting new, expensive medication when there are cheaper generic drugs available," says Hoek, "and there is also concern that people are self-prescribing."

Hoek and Gendall carried out a major survey of the New Zealand public's views on DTCA. "Our mail survey of the general public achieved a 64 percent response rate and resulted in a sample of over 600 respondents that was carefully drawn to ensure it properly reflected the New Zealand adult population. The findings reveal that, when asked if DTCA should be banned, nearly 70 percent opposed or strongly opposed this proposition, and only 11 percent supported or strongly supported it."

Many of the respondents were very aware of DTCA, says Hoek, particularly the television advertising.

"This awareness indicates the pervasiveness of DTCA and its potential to affect consumer behaviour."

However – a point in favour of greater regulation – the survey also revealed that consumers were much more likely to recall seeing details of medicine benefits than they were the risk or side-effect information."

In New Zealand the small-print is very small, and voice-over warnings are swamped by cleverly constructed images of happy, healthy consumers. This imbalance, says Hoek, poses a public risk.

"The trouble with most New Zealand

HOW TO STEAL A COMPETITOR'S THUNDER

One of Hoek's professional interests is ambush marketing. Described in a popular marketing journal as "a parasitic activity that encroaches on legitimate sponsorship", ambush marketing is where a firm engages in promotions that invade a rival's sponsorship. During the 1996 Atlanta Olympics, Nike ambushed Reebok, the official sponsor, by purchasing prominent billboard space overlooking Atlanta's Olympic Park.

Although ambushing is commercially irritating for the 'ambushed', this type of marketing typically obeys fair-trading legislation and can be defended as legitimate competitive behaviour, says Hoek.

"I don't think the question of whether ambushing is ethical is as important as the question of what activities competitors can legally engage in. If they can buy advertising rights to events that a rival sponsors, there is nothing illegal in their advertising. I think contracts need to be much more clearly defined and sponsorship rights need to be better co-ordinated to ensure loopholes are eliminated as far as possible."

Ambush signage – or the New Zealand Rugby Union's failure to promise a stadium free of it – can be blamed for New Zealand's loss of co-hosting rights to the 2003 Rugby World Cup.

The Atlanta Olympics when Nike ambushed Reebok also saw Hoek summoned to court as an expert witness. Fresh to New Zealand's communications market, BellSouth, a sponsor of the 1996 Atlanta Olympic Games, objected to Telecom's simultaneous print campaign parodying the five-ring Olympic symbol.

This article originally appeared in MASSEY *magazine.*

advertising is that it is not always balanced. There is frequently a lack of information about side effects, the cost and the risks."

In comparison, DTCA in the USA features a mass of detail – a full-page advertisement is often accompanied with another full page of information. Professor Hoek is currently working with a researcher at the University of Oregon, comparing advertising content and the different regulations.

A CATALOGUE OF ERRORS

Coverage error occurs when the sample doesn't represent a microcosm of the population of interest.
In the case of Budweiser vs Budejovicky Budvar, the survey failed to define particular segments of drinkers within the beer marketplace, an important oversight because the beers involved were premium-priced imported packaged beers (ie, belonging to a niche market).

Measurement error occurs when questions don't measure the particular issue. Push polling, where people are told negative information about a candidate before being polled, is an example of measurement error that can lead to biased estimates.
The Bud vs Bud survey featured four measurement flaws relating to the design of the survey, the administration of the survey and the interviewers' qualifications and conduct.

Sampling error depends on the size of the sample and the sampling technique used (the bigger the sample, the smaller the margin of error and the more precise the estimates).
The Budweiser researchers overlooked the important question of whether the estimates were unbiased. Of those classified as confused between the two brands, less than a quarter had consumed or purchased 'European' packaged beer within the past three months and many fewer still had purchased or consumed premium-priced imported beers, suggesting that the evidence of 'confusion' was based on the responses of people who were unfamiliar with the market partition.

Non-response error occurs when the people who don't answer a survey differ from those who do. Because they haven't answered, it's very hard to know when this affects the estimates obtained, which is why surveyors aim at a high response rate, to minimise the likelihood that NR error will seriously affect the estimates obtained.
The survey response rate was a source of contention in the Bud vs Bud case; the calculation presented bore no relationship to any standard response rate formula and was clearly inaccurate.

An entrepreneurial expert

If you think of entrepreneurship, you probably think of individuals. Say Richard Branson, now in New Zealand with Virgin Blue, Annita Roddick of the Body Shop or, more locally, Dick Hubbard or Stephen Tindall. Here they are, swashbuckling forth, toppling the status quo, creating wealth and opportunities and providing us, along the way, with superior products and services. We should, we feel, be more like them.

Professor Anne de Bruin

As a culture we are newly in love with entrepreneurism, with the idea of being entrepreneurs. But while there are plenty of puff-piece magazine stories and biographies lionising individual entrepreneurs, plenty of 'how to' and motivational books, there's very little published empirical and theoretical research into entrepreneurship or the conditions that foster it. This is a shame, for if we don't understand entrepreneurship, how can we encourage it?

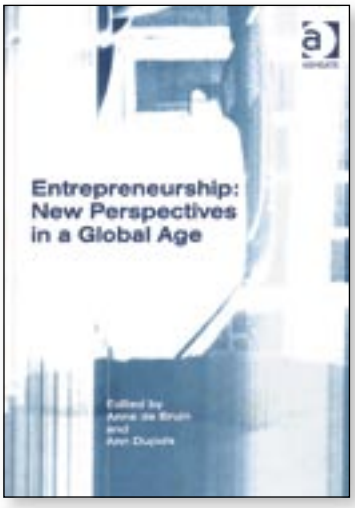
If there is a person who knows the state of research into entrepreneurship in New Zealand better than anyone else, it is must be Albany-based Professor Anne de Bruin, who with her colleague, Ann Dupuis, is the co-editor of *Entrepreneurship: New Perspectives in a Global Age*. Two of the chapters in this twelve-chapter, densely-referenced, academic text published in late 2003 have been authored by de Bruin, and she has co-authored another eight.

What makes for an entrepreneur? The answer you give may be a clue to where you are from. In New Zealand, Australia and Britain entrepreneurs are seen as being distinctively innovative, opportunistic and risk-taking; in America and Canada the view is more that anyone in small business is an entrepreneur.

The book nicely skirts the problem by defining entrepreneurship as a continuum. Branson sits on the continuum, but then so does the woman selling clothes at the Otara fleamarket. The book also adopts an approach of 'embeddedness': placing the entrepreneurial activity within the context of the surrounding social environment.

The book has chapters on familial entrepreneurship, indigenous entrepreneurship, youth entrepreneurship, ethical entrepreneurship and community entrepreneurship. Of particular relevance, given the rapidly-ageing profile of New Zealand's population, is a chapter on elder entrepreneurship. In the Netherlands and the UK 10 percent of people starting new businesses have been found to be age 50 and over. Hearteningly, these businesses have good survival rates: they are three times more likely to survive than businesses started by people in their teens or twenties.

Entrepreneurship can also be a part of government, both local and central. Just as the private sector can use resources in new ways to maximise productivity and efficiency, so too can the public sector. *Entrepreneurship: New Perspectives in a Global Age* has chapters on Municipal-Community Entrepreneurship and State Entrepreneurship.



In the latter, de Bruin proposes that the term welfare state no longer properly describes the function of the state in the global age and that a new term, the 'strategic state', should be employed. The strategic state acts entrepreneurially, and exhibits opportunity-related strategic behaviour.

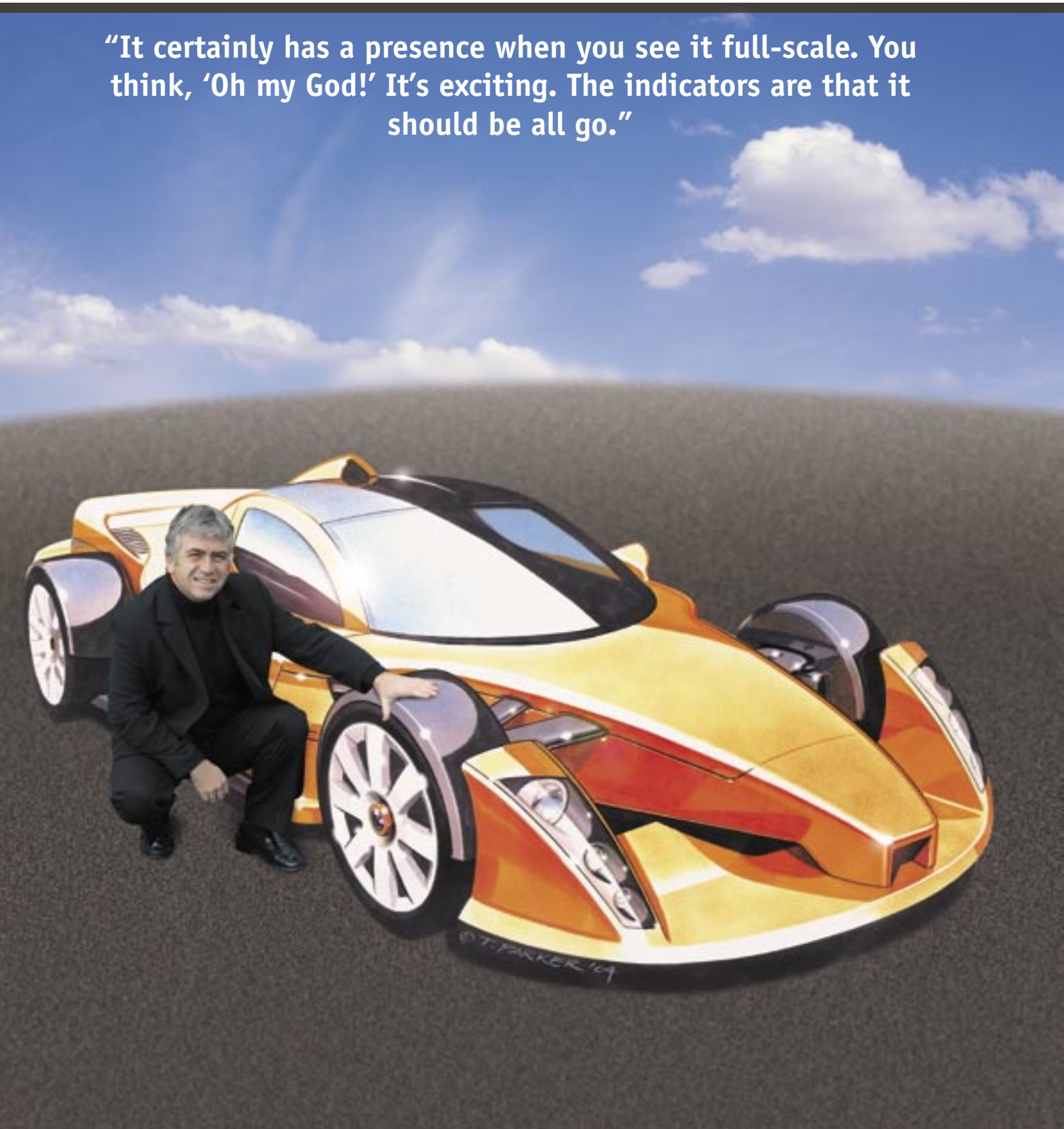
You can find expressions of the strategic state in Industry New Zealand, in the Ministry of Economic Development, in aspects of the Tertiary Education Commission and most explicitly in the 2002 policy framework, *Growing an Innovative New Zealand*, which sees the state assuming leadership in strategies for economic development that are based on fostering an effective innovation culture.

It seems entrepreneurship, far from being the province of the élite few, is everywhere.

This article originally appeared in MASSEY *magazine.*

Making his marque

"It certainly has a presence when you see it full-scale. You think, 'Oh my God!' It's exciting. The indicators are that it should be all go."



It's sleek, smooth and sizzles across the tarmac at a top speed of over 300 kilometres per hour. It has the open wheels and low, aerodynamic body of a Formula One racing machine and the come-hither curves of a top-class sports car. And it's designed and produced in New Zealand.

It's the stuff of dreams.

Certainly the stuff of Tony Parker's dreams. Massey's head of Three-Dimensional Design has wanted to design cars since he was a child. Now he is designing the Hulme F1 Champion, a high-performance sports car being developed for production in New Zealand.

Underneath a carbon-fibre chassis will be a six-speed sequential transaxle and a modified BMW M5 engine producing 300 kilowatts of power. That engine is unique – the makers of the Hulme, Supercars Limited, are the only company in the world to get the model.

Other major international companies are also contributing to the Hulme, ensuring that everything about it will be top-quality. The tires will be Pirelli, the ABS system Bosch, the air bags Siemens.

However, this is most certainly a New Zealand-made car. It has been conceived here and here is where it will be built, crash tested and produced.

The first Hulme chassis and two bodies are complete. Associate Professor Parker is now working on the design of the two-seat interior, as well as checking that the car being made matches the design.

"I'm learning an awful lot about that process! It's really very revealing, and fascinating and fun," he says.

A full-scale model of the car has been completed and a prototype will be running by the end of the year.

The company is also developing other variants of the Hulme: the Xtreme, an open, F1-type two-seater, and the Super GT for racing.

Next year Supercars Limited plans to produce a number of cars for crash testing, with production to start in 2006. From then they want to produce 75 to 100 cars a year. A minimum of 350 to 500 will be built.

A price has not yet been set, but it is expected to cost somewhere between $250,000 and $1,000,000.

The idea for a Kiwi-made supercar first came to Auckland entrepreneur Jock Freemantle, who approached Parker in 2002 to co-ordinate the design team. The two then developed the Two-Second Test for ideas of how the car would look.

The test was to put a drawing of the proposed car among a lot of pictures of various other sports cars, like Ferraris, Lamborghinis and Porsches. A car enthusiast uninvolved with the project then looked at the pictures for two seconds. If the proposed car did not stand out, it did not pass the test.

The first 15 designs failed.

Parker then started thinking about a sports car designed to resemble a Formula One racer. Formula One, of course, has a huge international following.

"Lots of people dream of being Formula One drivers and want to drive Formula One cars," he says. "So really that was the jumping-off point, the point of inspiration for this car."

Freemantle says that Parker has more knowledge of Formula One than anyone he has ever met. After Parker had spent a day thinking about the idea, at 6.30am the next morning he received an excited call from Freemantle. The entrepreneur had had the same idea – an F1-based design.

Strangely enough, it had come to him in a dream.

This car passed the Two-Second Test.

The Hulme takes its name from Denny Hulme, the great Kiwi driver who won the 1967 Formula One championship. New Zealand has a proud history of producing outstanding drivers, such as Bruce McLaren, Chris Amon and Scott Dixon. It has also been home to many talented automotive technicians, mechanics and engineers who have worked the pinnacle of international motorsport.

The aim is to use this base of technical skills, combine it with car sales experience, add imaginative design and come out with something special.

There have been other flashes of success designing and building motor vehicles in New Zealand. John Britten's groundbreaking, race-winning motorbike was sold in small numbers to fans in the U.S. and Europe, while Turnbull Engineering's Saker GT has won races in Germany and is available as a limited edition sports car. Designer Bruce Turnbull is now involved with engineering the Hulme.

Supercars Limited wants to follow in the footsteps of the boat-building industry, which has built an international reputation for low-volume, high-quality product, especially after New Zealand's success

in the America's Cup. Some of the techniques being used to build the car are modelled on boat-building technology.

Like the America's Cup team, or Peter Jackson, the Hulme project is relying on some Kiwi ingenuity to keep costs down.

"We do have some inventive ways of doing things," Parker says. "We use appropriate technologies for the economy that we live in and the circumstances that we have got, but that doesn't mean that it's not a well-considered, well-conceived, well-designed object. It just means that you can do things in a different way."

Parker studied industrial design at the former Wellington Polytechnic, then got a scholarship to the Royal College of Art in London, where he did a master's in design. There he worked next door to people who are now at the top of the automotive design field, which makes him confident that he too can conceive a great car.

When he returned to New Zealand he worked for about seven years before returning to his roots in Wellington to teach.

During his career he has designed electric tow tractors, forklifts, gynaecological lasers, safes, toys, computers, electric fence energisers, and more.

"I've worked on security products, petrol pumps, all sorts of objects, with good teams of people and good manufacturers that have won New Zealand a considerable amount of international funds … but one drawing of a car has given more notoriety than any of that stuff. I think it just shows that there is something deeply emotional about motor cars. Even though they may be wildly, outrageously out of our means, it doesn't matter; we are still absolutely fascinated by them, attracted to them and passionate about them."

Parker vividly remembers his father's love for cars and the care he lavished on his Jaguar. He also remembers a teacher mocking "flash" cars.

"It's just interesting how attached we become to these objects. They communicate a lot of our own values, whether we like it or not."

Some see sports cars as representing negative values – vanity, decadence and reckless speed. Parker is quick to point out that they are not encouraging people to try to imitate Michael Schumacher – at least not along Courtenay Place.

"We are not for a minute supporting the idea of some guy driving around Wellington like a Formula One driver. That would be stupid.

"I see it as a vehicle which is sort of an extreme recreation vehicle. And New Zealand is pretty good at extreme stuff."

Supercars Limited intends for Hulme buyers to be given instructions on how to handle the vehicle safely.

Parker expects the market for the Hulme to be small but potentially lucrative.

"A local entrepreneur told me recently that he was always looking for the deepest and narrowest niches. Well, I think we've found one which is pretty narrow, I just hope that it's very deep!"

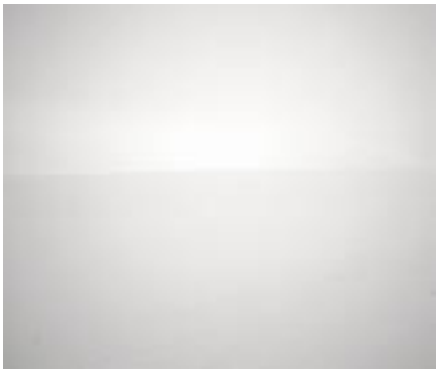
So far, the signs are it will be. Freemantle says that over the last 12 months, they have discussed the project and shown drawings and models to many journalists and motoring people from New Zealand and overseas.

"Everyone has said: 'It looks fantastic and exciting, if you can build it to the standard you propose, and at the price you have budgeted, you will sell as many as you can build.'"

Parker is also confident about the appeal of the Kiwi supercar.

"The indicators are that it should be all go. It certainly has a presence when you see it full-scale. You think, 'Oh my God!' It's exciting."

Imagining Antarctica



Every summer the annual migration arrives in Antarctica: the Hercules loaded with support staff, supplies and scientists. They come to measure such things as the hole in the ozone layer or to extract information about past climates from ice cores. They come – like David Lambert elsewhere in these pages – to conduct research into the pace of evolution.

But in recent times Antarctica New Zealand and Creative New Zealand have hosted a different breed of visitor: writers, painters, photographers, sculptors and multimedia artists. In 2002, Anne Noble was among them.

How do we see Antarctica? For most of us it is a place we will never visit in person. So what stands in for 'Antarctica' is a pastiche of familiar images and clichés: doughty explorers like Scott and Shackleton, mixed with scientists and penguins, and endless expanses of meringue-like glaciers and snowfields. Antarctica is a construct.

Noble began to investigate the 'Antarctic imaginary' while waiting to depart for the ice. She visited the Antarctic Centre and the Canterbury Museum and started to photograph what she could find of Antarctica in Christchurch, embarking on a project that has taken her as far as Scandinavia and Japan.

While in Antarctica, Noble considered alternative ways of re-presenting place. Her studies of the effect of light on white resulted in the sublime William's Field images. A second series of images, Fieldwork, framed the landscape through the activities and culture of science.

Anne Noble has been at the forefront of photographic practice in New Zealand since first attracting attention in the early 1980s with her acclaimed

William's Field, Antarctica 2002 Penguins, Canterbury Museum 2002

Wanganui River photographs. Work in series – often exploring the imagination and representation of place, memory and sensation - enables her to explore the photographic medium and its possibilities, in great depth.

In 2002-03 a major retrospective of her work, States of Grace, toured New Zealand. The book produced to accompany the exhibition, *States of Grace*, reveals the range and versatility of her work, from the celebrated Wanganui series of the 1980s to the dramatic and lusciously coloured Ruby's Room images. Inventive, idiosyncratic and often at once sublime and challenging, Noble's photography constantly explores new territories and new technologies.

Photographs from the ongoing series of Ruby's Room, 1997 – 2004, described by the artist as "an alternative archaeology of childhood", provide a highly original representation of childhood through an exploration of the things children – in this case the artist's daughter Ruby – do with their mouths. Ruby's Room is currently on show at Monash University Museum of Art in Melbourne.

As well as teaching photography at Massey's School of Fine Arts, Noble is also the Director of Research for the College of Fine Arts, Design and Music.

Although Noble has produced two substantial bodies of work from her two and a half weeks on the ice, Antarctica still beckons, and she hopes to return.

"The artists programme is such a crossover with science. Antarctica NZ send scientists to enquire into the nature of the continent and they are doing wonderful research. But alongside science, art asks its own equally significant questions about what we know and understand about the place."

William's Field, Antarctica 2002 Goal posts, Antarctica 2002 Field work, Antarctica 2002

Renaissance master

Like the Italian renaissance before it, the Māori renaissance has its masters. Professor Bob Jahnke, Massey's Head of Māori Studies, is one. Many New Zealanders will be acquainted with his work, even if sometimes unwittingly. In Wellington the magnificent stained-glass door at one end of the marae that is a part of Te Papa Tongarewa the National Museum of New Zealand is a Jahnke work. So is *Spinning Top,* a stainless steel sculpture in the suit-and-tie territory by Lambton Quay.

But Jahnke's own work is the least of it. His influence, and that of the Māori Visual Arts programme he introduced in 1991 and still co-ordinates today, is widespread. Artists Shane Cotton and Kura Te Waru Rewiri were other original programme members, and Cotton, whose works are highly sought after, continues to teach on the programme for the love of it.

From the beginning the programme has taken an avant garde and conceptual approach to traditional Māori art practice. "This can be challenging for some, especially those who may have concrete ideas of what Māori art is," Jahnke says.

Nonetheless, taha Māori is at the core of what the programme is about, says Huhana Smith, who left Australia to study under Professor Jahnke and is now an exhibiting artist and a curator at Te Papa. She says the programme's blend of art theory and Māori culture is ideal for students who might not know much about their culture but recognise it as an essential part of their artistic identity.

Jahnke's own undergraduate years were spent at the Elam School of Fine Arts at Auckland University. Later he would complete a masterate at the California Institute of the Arts. At Elam he had wanted to keep learning te reo Māori, but the language classes would not fit with a full schedule of studio work. The Māori Visual Arts programme includes compulsory papers in te reo Māori and the Treaty of Waitangi.

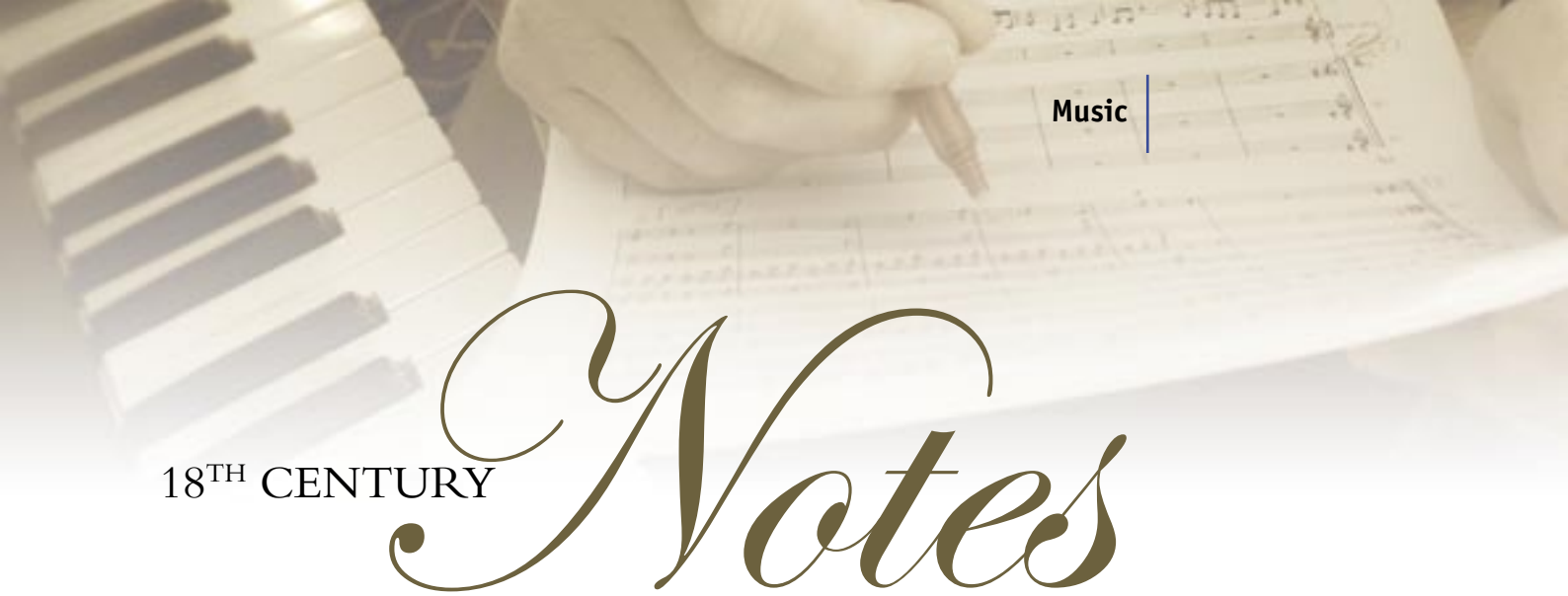
Saffronn Te Ratana, a recent master's graduate, believes the work emerging from the programme should change the way people think about contemporary Māori art, indeed she likens the programme to a movement. Her own works are represented in the collections of Te Papa and the Auckland Art Gallery.

Author and artist Michael Dunn recognises Jahnke as one of a generation that "has placed bicultural issues and protest at the centre of its art".

The issues of globalisation and cultural appropriation are referenced in *You Too Can Be a Māori*, a work that Jahnke exhibited and sold last year as part of a highly successful exhibition of Māori art in Vancouver. *You Too Can Be a Māori* is a triptych of photo-engraved acrylics showing British pop star Robbie Williams, Māori leader Piri Sciascia and boxer Mike Tyson, all wearing variations of traditional moko.

His most recent sculpture series may be seen as part commentary on the sea bed and foreshore issue. *Piki Ake nga Tāruke*, is a sequence of three electropolished stainless steel sculptures of tāruke or crayfish pots, which, depending on the direction in which they are read, are either sinking into or rising from the foreshore.

Left and right: Details from the stained-glass door made by Robert Jahnke that forms part of the Te Papa marae. The door represents Ranginui, the sky father.
(F.004869/05, I.005480)
Bob Jahnke/Te Papa Tongarewa
Below: *Spinning Top*, a stainless steel sculpture at the head of Wellington's Woodward Street.



18TH CENTURY Notes

Dr Allan Badley, Director of the Centre for Eighteenth-Century Music, is one of the world's leading authorities on music of the late 18th-century. He has edited and published over 250 works by major contemporaries of Haydn, Mozart and Beethoven, and the publishing house he co-founded in 1995 with Klaus Heymann of Naxos is widely regarded as the most important specialist publisher in the field. Recordings based on Dr Badley's editions have won a number of major international awards. He holds the Silver Medal of the Internationale Ignaz Joseph Pleyel Gesellschaft in recognition of his contribution to Pleyel scholarship.

Are you from a musical family?

My maternal grandmother was the most important early musical influence on my sister and me. She was a very fine pianist who had studied at the Sydney Conservatorium shortly after the First World War and on returning to New Zealand she taught privately for many years as well as often working as an accompanist. This is how she met my grandfather, a keen amateur singer in his younger days. My grandfather's second cousin, Peter Dawson, was one of the most popular singers and recording artists of the 1920s and 1930s. My sister is a very accomplished musician and is currently the head of the music department at St Matthews School in Masterton.

Did you set out to become a scholar or a musician?

Although I always enjoyed playing, I never felt drawn to the idea of playing professionally, probably because, as a pianist, I could see nothing ahead but a lifetime of private teaching. While still at school I discovered a mysterious discipline called musicology, which seemed to combine so many of my burgeoning interests: music, history, literature, archaeology and even detective work. By the time I arrived at university I was already an 18th-century buff; within five years I had progressed to the point of wild-eyed fanaticism.

What path did you follow to get to where you are now?

Having completed my MMus at the University of Auckland and, along the way, settled on a PhD topic, I set to work doing the preliminary source work for my thesis on the concertos of Leopold Hofmann (an important but obscure Viennese contemporary of Haydn). I headed off overseas in 1981, first to Canada where I had been awarded an Open Doctoral Fellowship at the University of Toronto, and then on to Vienna. At this stage I intended to spend six months or so in Vienna and then return to Toronto to take up my Fellowship. However, like many before me, once there I stayed. The opportunity to work with original source material proved irresistible. Almost every day I seemed to be making important new discoveries in church and cathedral archives, private palaces, monasteries and state libraries. I worked in Germany and around Austria; I even worked in archives in Budapest, Prague and Brno seeing myself as a kind of musicological Cold War warrior. It was pretty heady stuff and hardly surprising that I deferred my return to Toronto for another year. While in Vienna I also met some of my musicological heroes – foremost among them HC Robbins Landon, the great Haydn scholar – and they showed a flattering interest in my research. The experience of discussing knotty, technical problems with scholars like Landon, Otto Biba and Daniel Heartz soon convinced me that going back to Toronto would be a mistake. The material was all here, and my thesis could be written anywhere. I decided to stay in Vienna as long as I could – I'd also met my future wife by this time – return to Auckland, submit my thesis, and then return to Vienna to begin my real life's work. We returned to New Zealand in 1985 (Satomi had just graduated from the Musikhochschule in Vienna) and, after I duly finished my thesis and received my PhD, we flew back to Vienna, where I resumed my research work and started the long and frightening search for gainful employment. Over the next few years we moved around a good deal, including a short spell in Ireland, where I taught briefly at University College, Dublin. An offer of a Postdoctoral Fellowship at Otago brought us back to New Zealand in 1988, and we moved to Wellington the following year when Satomi joined the New Zealand Symphony Orchestra. In the early 1990s I taught part-time at Victoria University (and, very briefly,

I was already an 18th-century buff; within five years I had progressed to the point of wild-eyed fanaticism.

Allan Badley is currently engaged on three major research projects for the Centre: an edition of the complete chamber music of Joseph Boulogne Chevalier de Saint-Georges; an edition of the complete piano sonatas of Ferdinand Ries; and, together with the Austrian scholar Dr Heinz Anderle, an edition of Ignaz Pleyel's 1785 opera *Ifigenia*.
All three composers have interested Badley for years and he has played an important role in reviving international interest in their works. Pleyel and Ries were considered very important figures in their day.

Ferdinand Ries (1747–1838)

Ferdinand Ries was not only a pianist of formidable power and an unusually gifted composer, but he also remained (with odd intervening periods of hostility) one of Beethoven's most trusted friends right up until the older composer's death in 1827. Ries composed successfully in most genres and his piano concertos and sonatas are of particular interest given his connections with Beethoven. Allan Badley's edition of the complete works for piano and orchestra promises to be a major musical landmark. Two of the eight concertos are to be recorded in February by Christopher Hinterhuber, winner of the Beethoven Competition, with the NZSO conducted by Uwe Grodd. The edition of the complete sonatas begins with the Sonatas Op.1, which were completed in 1804 and dedicated by Ries to his teacher Beethoven. The works received a lengthy and generally favourable review in the *Allgemeine Musikalische Zeitung* and doubtless Beethoven pored over the works suspiciously before allowing the dedication to proceed. Perhaps as a mark of his approval Beethoven allowed Ries to make his début in Vienna as a soloist with a performance of one of his own major works, the Piano Concerto in c minor, Op. 37. Although Ries studied piano with Beethoven rather than composition (a nice touch, since Beethoven's most important keyboard teacher was Ries's father), there is little question of the influence he exerted on Ries's development as a composer. Strangely enough, Ries's keyboard writing quickly moved away from Beethoven's own style towards that of Hummel and the early Romantics. His keyboard sonatas – like the concertos – represent one of the most important series of works composed in Beethoven's lifetime. The modern premières of these works will all take place at Massey University under the auspices of the Centre for Eighteenth-Century Music.

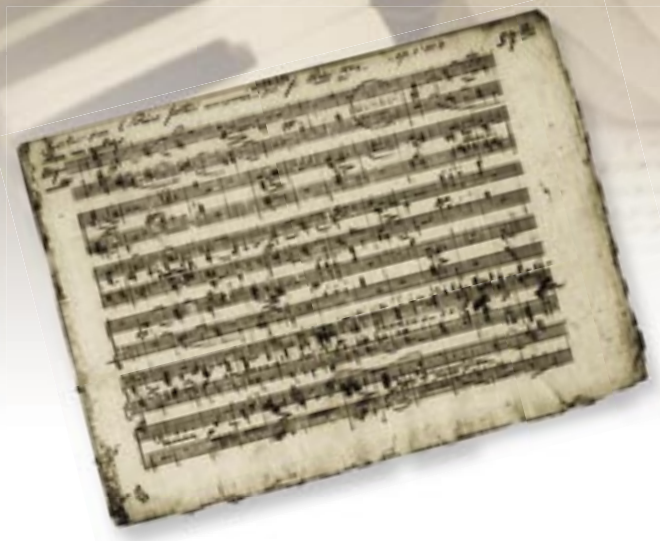
at the Conservatorium of Music) and managed the New Zealand Chamber Orchestra. My research work on Hofmann continued, and I worked a good deal with a chamber orchestra in Vienna, who were performing and recording some fairly rare and exotic repertoire. I had always been interested in editing works for performance – indeed, I conducted the first-ever modern performance of a Hofmann symphony while a student at Auckland and an all-Hofmann programme with the Dunedin Sinfonia in 1988 to mark the 250th Anniversary of the composer's birth – so these activities dictated to a certain extent the thrust of my research work at the time. In 1995 I founded the publishing house Artaria Editions with Klaus Heymann of Naxos to begin a systematic and large-scale exploration of music of the late 18th century. The project was – and remains – unique in the musical world not only for its sheer scale (we have now published over 400 works) but also in its integration of research, publishing, performing and recording. Our work has had an enormous impact on the wider perception of music of the late18th century. An indication of this is the success our recordings have enjoyed on the world stage: we have won 'Best 18th-century Orchestral Recording' category at the prestigious Cannes Classical Awards on three occasions and, significantly, with composers many would consider to be hopelessly obscure. These successes – and the performances which flow from them – have vindicated our work in bringing the composers back from the brink of extinction and provided for the first time the means upon which to build a more detailed and accurate evaluation of the music of the period. The same principles are being applied to our work at the new Centre for Eighteenth-Century Music: rigorous research with practical outcomes in mind– publications, performances and recordings of international significance.

How do you go about your work?

Much of my work time is spent alone at my desk or at the keyboard (either my trusty synthesiser or more-favoured piano), but in the lead-up to performances and recordings I work as closely as possible with the artists. When works are recorded in New Zealand it is a good deal easier for me to be directly involved in the process than at other times, but it is amazing how many ideas can be conveyed via e-mail or lengthy telephone calls. The phone calls are the most fun as they almost invariably end up with me listening to the orchestra via the conductor's cell phone and then sending critical comments back down the line concerning possible variant readings, nuances in interpretation and so forth. These calls might come from anywhere – Sweden, Germany, Hungary, Canada, Portugal – but the process is always the same: listen, approve/argue, propose an alternative (sing it!), listen again. Not as much fun as being there, of course, but supremely invigorating nonetheless! Working with other musicologists on editions is a good deal less frantic but no less stimulating as so many new and exciting ideas tend to emerge from the process. These can range from a re-evaluation of a tricky editorial problem to the discovery of otherwise unknown works. The scholars I work with on an almost daily basis are not only undisputed leaders in the field but are also a uniquely pleasant group of individuals.

How much is technology changing things?

Improvements in technology over the past decade – and in particular, the development of sophisticated and flexible music notation software – have made a big impact on the kind of work I do. Projects which even 20 years ago would have been completely unviable – an edition of the complete Wanhal symphonies, for example – are now perfectly feasible. The interface between computer and synthesiser adds a new dimension to the process of editing and proofing. The ability to play through works in all voices through the synthesiser is enormously helpful in planning performances and recordings. It



is possible to experiment with different tempi and even focus on problems relating to individual parts or sections of the orchestra. All this can be done using one's musical imagination, of course, but the use of such technology is extraordinarily useful. Streaming music via broadband also promises to have a major impact on our work since I believe that an increasing number of recordings of highly specialised repertoire will be made primarily with this market in mind. The reduced production costs will allow an even greater number of recording projects to be undertaken. Although technology is playing an important role in source research and the processes of publication, recording and dissemination of music, the most challenging problems in editing call for creative, musical solutions. The technology helps – a synthesiser is like a captive (unmusical) orchestra – but ultimately the solutions are arrived at by very traditional means and a thorough understanding of contemporary compositional and performance practices.

Where you can't establish the provenance of a piece through documentary evidence, how do you determine the composer?

Establishing authenticity is one of the biggest problems in 18th-century music given the paucity of autograph material and authentic copies. Scholars are generally agreed upon how best to proceed in terms of establishing a hierarchy of reliability of sources, and yet all too often we find that a work – often an important work – survives in a single copy of unknown provenance in spite of our best efforts to identify contemporary professional copyists and paper types. Once one is reduced to deciding a work's authenticity on stylistic grounds (i.e. on internal evidence), the picture becomes even more confused. The American scholar James Webster once pointed out that to decide a work's authenticity on stylistic grounds means having to prove that no other composer could possibly have written it. This is a tough ask, particularly when dealing with secondary figures about whom we know comparatively little. To illustrate how problematic this can be, we need only consider the case of the Haydn D major Cello Concerto. For many years it was believed that this work may have been composed by Haydn's principal cellist, Anton Kraft. Examined from every stylistic point imaginable the work just didn't seem to be convincing as Haydn ... until one day Haydn's signed-and-dated autograph score was discovered in the cellars of the Austrian National Library! Very often, though, there is no alternative but to make a judgement call based on style, and one relies almost as much on gut instinct as on a detailed knowledge of the composer's style. Most scholars have made mistakes, and as we learn more I dare say more of these mistakes will come to light. It is very frustrating, though, to see works still being performed under the wrong composer's name after the question of authenticity has been settled. One of Leopold

Joseph Boulogne Chevalier de Saint-Georges (1745-1799)

Joseph Boulogne Chevalier de Saint-Georges was one of the most remarkable men of the 18th century. Born in Guadeloupe to an aristocratic French planter and a beautiful Senegalese slave, Saint-Georges was educated at a prestigious military school in Paris, where he excelled in every physical pursuit from swimming to dancing. By his early 20s he was regarded by connoisseurs of fencing as perhaps the finest swordsman in Europe. If that were not enough, Saint-Georges was also a violin virtuoso of the first rank and a composer of extraordinary ability. He combined the careers of athlete and artist with great success and continued to fight exhibition matches even when his musical career was at its zenith. Saint-Georges formed and led a Black Militia during the revolutionary period and suffered a period of imprisonment during the Terror. After a brief and disillusioning visit to Haiti in the late 1790s, Saint-Georges returned to Paris, where he died in 1799.

This remarkable man has attracted a great deal of interest over the years and a considerable number of his works have been published (the majority edited by Badley) and recorded. Saint-Georges's chamber music, however, remains largely unexplored and Badley's complete edition, being prepared under the auspices of the Centre for Eighteenth-Century Music, promises to shed important light on this aspect of the composer's work. The first volume, Three Sonatas for Violin & Fortepiano, Op. (b), was published earlier this year and the works are to be recorded (along with the Sonatas Op. Post, No.1) in Germany later this year by the Japanese violinist Takako Nishizaki.

Ignaz Joseph Pleyel (1757–1831)

More editions of Pleyel's music were printed in the late 18th and early 19th centuries than of any other composer – including his teacher Joseph Haydn – and for a time at least he was easily the most famous and popular composer in Europe. Such was his reputation that a society devoted to the performance and promotion of his music was founded in the whaling port of Nantucket in the early years of the 19th century. This remarkable man also established a highly successful music publishing house, and a piano manufacturing business which is still thriving in Paris today. Pleyel wrote only two works for the stage – the charming marionette opera *Die Fee Urgèle*, composed at the age of 19, and the opera seria *Iphigenie*, written for the Teatro San Carlo in Naples in 1785. *Iphigenie* is particularly interesting because it combines both local (Neapolitan) traditions, particularly in its treatment of the voice, with the fully fledged and complex symphonic style of the composer's mature symphonies. The edition being prepared by Badley and Heinz Anderle for the Centre for Eighteenth-Century Music will be used for the modern première of the work in Austria next year. The Centre will also publish *Die Fee Urgèle* in 2006.

Nonetheless, as the secondary figures begin to emerge from the shadows I think many of these problems will disappear, except, perhaps, where the original mistake is in itself hallowed: Brahms's 'Variations on a Theme by Haydn' will forever conceal Pleyel's authorship of the theme in question.

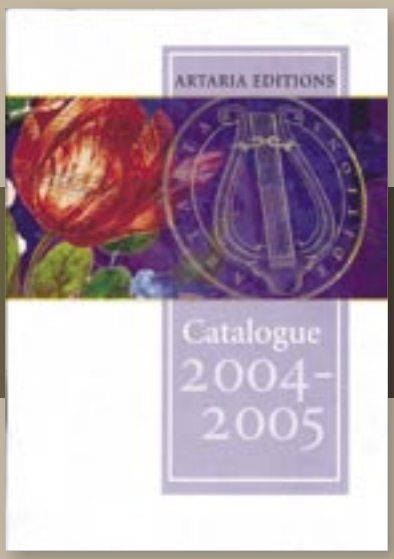
You must have cause to ruminate on the nature of fame and reputation. Just how arbitrarily do you think reputation is assigned? Why is a composer acclaimed during his or her day and then forgotten?

One of Leopold Hofmann's Flute Concertos is still frequently offered as a Haydn work over 70 years after the misattribution was first discovered.

The selections made by history generally have been pretty much on the mark. However, the obscurity of many 18th- and early 19th-century composers is undeserved. A number of these figures were composers of enormous vitality and imagination and their later obscurity owes much to the fact that there was no conception of a classical canon until comparatively recently. It is only in the past few decades that any serious work has been done on the so-called secondary figures (Haydn's symphonies – one of the cornerstones of the classical repertory – were not published in their entirety until the 1960s). Only now – and as a consequence of the kind of work I have been doing for so long – are we beginning to realise the extraordinary riches to be found in this missing tradition, and with this comes a curious paradox: Haydn, Mozart and Beethoven emerge as less original than first thought and yet at the same time incomparably greater since the music of their most talented contemporaries was so good. Nothing we discover will upset the essential rightness of placing these composers at the top of the heap, but context will change everything. I'm also convinced that the day is not too far off when it will not be heretical to say that a good symphony by Wanhal is better than a weak symphony by Haydn and that Joseph Martin Kraus wrote far more interesting sonatas than Mozart. As a result, the classical canon and all of our musical lives will be enriched and the current ossification of classical music may be reversed.

What do you listen to outside of your musical specialisation?

Cricket!



Massey University Postdoctoral Fellowships

Associate Professor Frank Sligo is leading a study examining how literacy and employment intersect. A to-be-appointed Postdoctoral Fellow will join an FRST-funded (Foundation for Research, Science and Technology) team researching adult literacy and employment in Wanganui and districts. The Fellow will create a complementary stream of research within small-to-medium size enterprises (SMEs) to explore literacy-related impediments to enterprise development and to help construct a theoretical framework within which to view adult literacy and employment, and the growth of SMEs.

Dr Cory Matthew is investigating the segmental morphology of grasses. The project will identify grass plants with superior root uptake and will be linked to a separate gene-mapping project to find DNA markers that identify the plants with superior root performance. The project findings might lead to lower farm fertiliser costs and better water quality in streams and lakes.

Associate Professor Bernd Rehm is investigating the ability of micro-organisms to produce polymers. "Some polymers, such as xanthan and dextran, are already commercially produced from renewable resources based on a biotechnological process. My research activities are focusing on the microbial production of biodegradable biopolymers, such as bioplastics and gel-forming polysaccharides, and how bacterial cells produce these polymers. The understanding of the biosynthesis process enables the optimisation of the production as well as the production of novel tailor-made material for certain applications." Because the polymers are naturally biocompatible, he and his colleagues hope to produce biomaterials that can be used for high-value medical applications.

Dr Emily Parker will study an enzyme, absent in humans, that catalyses an essential metabolic function in bacteria. Her work may have implications for the drugs used in combatting pathogenic organisms, which are becoming increasingly resistant to antibiotics. "Our studies will include a detailed investigation of the workings of this enzyme, and probe its evolutionary relationship to other similar enzymes. This work will underpin the development of both broad-spectrum and species-specific inhibitors as novel antibiotics."

Dr David Harding is setting out to make new, semi-synthetic mucin-based polymers. Mucus contains a large amount of mucins – compounds that contain a lot of carbohydrate and some protein. Dr Harding intends to chemically modify mucins and then study such things as adhesiveness, permeability (to gases and liquids), the effect of enzymes, flow properties, biodegradability, chemical degradability, and potential attachment sites.

Associate Professor John Overton will explore the question of what constitutes indigenous development. "This project seeks to ask how indigenous developmental goals and needs differ from the developmental goals and needs of other 'developing' populations. In doing so we will attempt to broach the divide that generally tends to separate work on indigenous peoples residing in the 'developed' countries of the world (the fourth world) and those who reside within the 'developing' world."

Dr Craig Johnson will investigate how to measure pain in animals. "The perception of pain is the most subjective and variable of the senses. A person's state of mind can have more influence over the way in which pain is felt than the intensity of the painful stimulus itself. The most accurate way to assess human pain is to ask the patient how much pain they are in, but this is not possible with veterinary patients." Dr Johnson's project will investigate using the electrical activity of the brain to give information about the perception of pain in animals.

Dr Robyn Phipps is to investigate sustainable technologies for keeping New Zealand homes warm, dry and free of combustion products. Her work will form part of a large Health Research Council-funded study. The project team will be looking at the health and environmental benefits that can be gained from increasing the insulation in 300 homes and heating them using technologies that do not release combustion products or moisture into the home. A to-be-appointed Postdoctoral Fellow will capture and analyse home air samples and investigate heating byproducts.

Professors David Lambert and **Mike Hendy** will employ a researcher to extract and analyse mitochondrial DNA from the remains of Antarctic silverfish preserved during the past 10,000 years. The silverfish are the main food source of snow petrels, which carry the fish back to their nests to feed their young. The silverfish also form part of the projectile vomit which the birds use as a defence mechanism. Over the years the layers formed on the rocks have been preserved in permafrost. These layers present a unique opportunity to observe the changes in mitochondrial DNA over time.

Professor David Penny, a principal in the Allan Wilson Centre, will fund a Massey researcher to detect mutants of hepatitis B viruses that are escaping current immunisation strategies. The work is being carried out in conjunction with the Fiji School of Medicine. "Our project is the only one conducting the necessary genetic analysis on HBV escape mutants in the Pacific and therefore continued monitoring and evaluation are essential to maintain HBV control. The researcher will also work in close collaboration with the University of the South Pacific."

Massey University Postdoctoral Fellowships recognise researchers with established research records, enabling them to either take on young postdoctoral researchers to carry out research or to undertake the research themselves.

Dr Barbara Ambrose, lecturer, Institute of Molecular BioSciences, receives a University Technical Assistance Award for her project *Functional characterisation of the AGL66 Group of MADS-box genes.* MADS-Box genes are a large family of plant transcription factors that have diverse roles in plant development, from the specification of floral organ identity to root development. Plant MADS-box genes are needed to specify the identity of cells or tissues, but only 20 out of more than 100 MADS-box genes have been functionally characterised in *Arabidopsis thaliana*, a small flowering plant that is widely used as a model organism in plant biology. Some of the AGL66 group, highly related MADS-box genes, are expressed in the reproductive axes, suggesting these genes are needed to specify reproductive cell types. Ms Ambrose will explore functional characterisation of the AGL66 group, with funding for a technical assistant allowing maintenance and organisation of a fast-growing collection of *Arabidopsis* genotypes, including planting, plant care and collection of tissue. Production of all possible genotypes will generate preliminary data needed to apply for outside funding.

Dr Gill Norris, senior lecturer, Institute of Molecular BioSciences, receives a UTA for her project *Unravelling a Catalytic Mechanism.* Peptide N-glycosidases (PNGases) are enzymes that cleave intact sugar chains from N-glycosylated proteins. Although the structure of a bacterial protein PNGase F from *Flavobacterium meningosepticum* was solved 10 years ago, the molecular details of the catalytic mechanism and its broad substrate specificity have never been discovered. Further, eukaryotic PNGases have no detectable sequence similarity to PNGase F and there are no structures for these enzymes. Dr Norris will use the technical assistance award to transform *E. coli* cells with plasmids containing DNA coding for mutants and to produce and purify the mutant PNGases for crystallographic and kinetic studies. If time allows, an appointee will set down crystallisations and begin kinetic studies.

Dr Isabel Castro, lecturer, Institute of Natural Resources, receives a UTA for her project *Sociobiology: the Southern Perspective.* This project, which started in 2003, looks at the evolution of behaviour associated with mating and investment in the offspring of saddlebacks and kiwi. In the summer of 2003/2004 Ms Castro banded and blood sampled at least one member of each of 20 pairs of saddlebacks and followed 12 nesting attempts, including banding and blood sampling chicks. Every four weeks the birds are observed in order to collect information about their behaviour and on habitat partitioning. Ms Castro is also following the mating and parenting behaviour of kiwi on Ponui Island. Thirty-three birds were caught, blood sampled and tagged with transmitters in March. Ms Castro is now following the birds to determine when nesting starts, and is collecting information on parental investment and mating systems.

Dr Peter Farley, lecturer, Institute of Molecular Biosciences, receives a UTA for his project, *C. albicans glucose transporters.* The yeast *Candida albicans* is an opportunistic human pathogen, with nearly 75 percent of otherwise healthy women experiencing vaginal infection by *Candida* species. *Candida* are also among the top four causes of infections acquired in hospitals and cause mortality in 35 to 40 percent of patients. *Candida albicans* mutants that cannot undergo morphogenesis do not cause disease. Glucose induces morphogenesis and is the main inducer present, but how this works is not understood. The experimentally based working hypothesis is that glucose triggers morphogenesis by binding to a specific extracellular receptor protein belonging to the glucose transporter/signaling family. Identifying the receptor is the ultimate goal. However, *Candida albicans* genome contains 28 glucose transporter/signalling proteins. A few will act as sensors and therefore will be unable to transport, and the research intends to identify these sensors.

Dr Subhas Mukhopadhyay, lecturer, Institute of Information Sciences and Technology, receives a UTA for his project, *Design and Development of a Low-cost Smart-sensing System for the Dairy Industry.* Dr Mukhopadhyay proposes to develop a sensing system using planar coils to predict the composition of cow's milk. His initial work using a network analyser to measure the ratio of voltage between the sensing coil and the exciting current gave promising results, which have been published, but the apparatus is costly. He intends to carry out further analytical modelling work and to build and test a low-cost prototype.

Anne Noble, senior lecturer, School of Fine Arts, receives a UTA for her *Southern Lights* project. Ms Noble has been invited to develop a new creative work for Christchurch City Art Gallery Tait Electronics Antarctic Gallery. The work will comprise a suite of photographs of light on ice, an evocation of the state of whiteout. The images will be sourced from Ms Noble's Antarctic photograph series, which she made as an Antarctic Fellow in 2002, with the new component for the exhibition being a suite of light boxes adapting commercial light box technologies to photographic images of maps of Antarctica. The maps are not conventional maps, but photographs of representations of maps sourced from games, school books, museums, educational environments and entertainment centres.

Stuart Shepherd, lecturer, Department of Art and Design Studies, receives a UTA for the development of a new body of sculptural artwork including collaborative kinetic work. This work will extend themes and techniques initiated for Mr Shepherd's master's degree four years ago. His work explores the boundaries between entertainment and fine art. He is interested in the ideas and expectations the public invest in the gallery space compared to the expectations and experiences evoked by the multiplex. The new body of work crosses boundaries between traditional fine art practice and popular culture. The elements that make Mr Shepherd's work particular to New Zealand draw somewhat from his research into self-taught and visionary art in New Zealand. The materials and recycled objects used have an aesthetic that could be labelled New Zealand Backyardism, and reflect a tradition of conservationism and the recycling of an island culture.

Massey University Technical Assistance awards of up to $10,000 are awarded to provide assistance for specific research projects.

Massey University Research Fellows

Dr Simon Tipping, from the Conservatorium of Music, has been granted $11,830 for two projects. The first is a study into large community choirs in New Zealand and England; the second, to write a history of the Christchurch Symphony Orchestra from 1961 to 2004, examining how the community music organisation has overcome an "often cheque red early career to become one of the premier performing bodies in the country". Dr Tipping is currently in Britain studying 32 large choirs, interviewing choir leaders, examining the relationship of these organisations to their communities and the challenges facing them in terms of membership, repertoire, audiences and finance. He plans to repeat the study with community choirs in New Zealand when he returns.

Professor Margaret Trawick will complete a book about the verbal customs of South Indian Tamil women belonging to Dalit (formerly called 'untouchable') castes. The book is the culmination of 30-years work. Professor Trawick undertook fieldwork projects in Tamilnadu, South India, from 1975 to 1990. Part of this included tape-recording, transcribing and translating women's funeral laments, which draw on the life-story of the individual singer. Once the book is published, Professor Trawick intends to return to Tamilnadu to distribute copies to her interview subjects. Professor Trawick's research interests include medical and linguistic anthropology, Tamil language and culture, modern warfare, and South Asia.

Massey University Research Fellowships provide up to $20,000 to the recipient's department, institute or school to free him or her from some normal teaching and administrative duties so that a current research programme can be completed or documented.

Māori Research Award

Jhanitra Murray from the School of Psychology is the recipient of the annual University Māori Award which facilitates the completion of research for Māori advancement and development. Mr Murray's PhD thesis, *Te Aronui ta te Māori Matai Hinengaro: Theorising a Māori Psychology*, will focus on the essential components that make up a Māori psychology. He will begin by examining Māori cosmogony (theories relating to the beginning of the universe), epistemology (the nature of knowledge), ontology (the metaphysics of the nature of being), and colonisation. Mr Murray says he understands Māori psychology to mean the way in which Māori understand their origins, and how these understandings have influenced Māori perceptions of themselves and the world they live in. His research will particularly focus on the formative interactions on the marae as a vital process for Māori psychology.

Top Achiever Doctoral Scholarships

All five doctoral students who applied for Government-funded Top Achiever Doctoral Scholarships were successful.

Sandra Brown, a senior research fellow at the SHORE Centre in Auckland, is to find the most effective evaluation method for providing development assistance and for monitoring and measuring outcomes in Māori community development. The aim is to identify the best way to evaluate whether the increasing number of development programmes being implemented by iwi and other Māori groups are effective, and which is most successful.

Judith Engelbrecht, from the Institute of Information Sciences and Technology, will develop a model to determine how information systems can be used to enhance decision-making in primary health care, in particular in relation to the new primary health organisation environment.

Barbara Plester, from the Department of Management and International Business, is to undertake a study to establish the relationship between the use of humour and the prevailing organisational culture inside a variety of New Zealand organisations. The research will also attempt to uncover actual organisational outcomes that arise from the use or misuse of humour at work.

Raewyn Poulsen, Institute of Food, Nutrition and Human Health, is to investigate the potential of bone-active nutritional factors as an alternative to hormone or oestrogen replacement therapy to prevent osteoporosis in post-menopausal women.

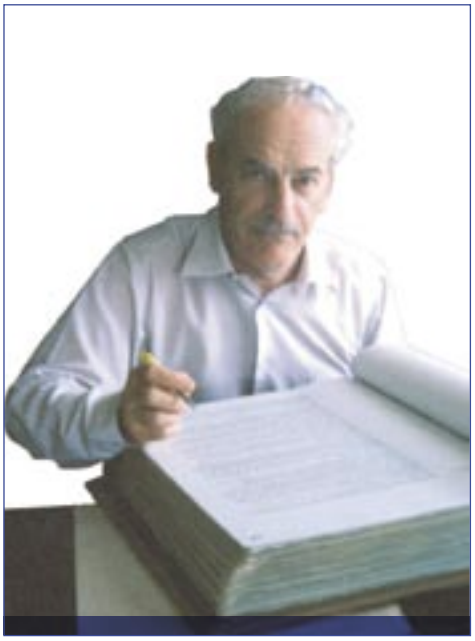
Benedict Van Hooijdonk, Institute of Natural Resources, is to try to understand the phenomenon of dwarfing rootstocks used in New Zealand's apple industry. It is hoped the study will determine a critical stage of development when the architectural traits of dwarfing are first expressed and the hormonal basis for this, with the aim of developing genetic markers and architectural models that improve the effectiveness of rootstock production.

Each PhD student will receive $25,000 a year, plus $3,000 per year for conference travel and fees.

University Women's Awards

Dr Inga Hunter from the Department of Information Systems: *Patient Controlled Access to EHRs.* Dr Hunter will investigate New Zealand patients' views about who should be able to access their Electronic Health Record (EHR).
Dr Mary Salisbury from the School of Social & Cultural Studies: *Multilingualism of Pukapukans.* Dr Salisbury's research focuses on Pukapukan, a language of the Northern Cook Islands, as part of a wider interest in Polynesian and Oceanic comparative linguistics and lexicography.
Dr Barbara Crump from the Department of Information Systems: *A Cross-National Study of Gendered Patterns in Computing.* Dr Crump's New Zealand-based project aims to identify and evaluate current work practices and the computing culture within the IT industry and their impact on gendered divisions of labour and power.
Ms Jeanie Douche from the School of Health Sciences: *Caesareans: Birth choice study.* This qualitative study explores the multiple discourses that constitute womens' choices for a caesarean section when there is no clinical reason. It is part of her PhD in progress.
Dr Jean Gilmour from the School of Health Sciences: *Endometriosis and the Internet.* This project will examine the quality of information provided by the major endometriosis internet sites and the representation of endometriosis produced throughout these sites.
Dr Celia Briar from the School of Sociology, Social Policy & Social Work: *Working Women's Health.* Dr Briar's project, will gather national and international contributions on the health effects of gender inequality at work and the health effects of overlooking women's difference in the workplace.
Dr Sita Venkateswar from the School of People, Environment & Planning: *Poverty, Empowerment and Grassroots Democracy.* Dr Venkateswar will be based in Kolkata, India, to examine the short- and long-term impact of voluntary initiatives to address poverty, on the young women undertaking the work, their families and the larger community.
Dr Jill Bevan-Brown from the Department of Learning and Teaching: *Māori Learners with Special Needs.* Dr Bevan-Brown's project is an investigation of Māori perspectives of visual impairment, to be included in her book on Māori children with special needs, drawing together 15 years' work.
Dr Janet Sayers from the Department of Management & International Business: *Journal Outputs from PhD.* Dr Sayers will write several specialist journal articles from her doctorate examining retail service work from a consumer's perspective.

The University Women's Awards enable women researchers to take time from heavy administrative and teaching workloads to either write up research results for publication, or to collect and analyse further data.



Professor John Dunmore's lifetime research interest has been the exploration of the Pacific by the French, a field where his pre-eminence is internationally recocognised.

John Dunmore was born in France, and educated there and in the United Kingdom. After a period teaching in New Zealand he studied for a PhD at Victoria University of Wellington, then became a lecturer at Palmerston North University College, an antecedent of Massey University. As Massey University's foundation Professor of French (1966–1984), and Dean of Humanities (1968–81), he was a strong supporter of the Humanities, a tireless advocate of the importance of language learning – in schools as well as at tertiary level – and set up teaching programmes in European and Asian languages, linguistics and second language teaching.

Professor John Beaglehole of Victoria University had suggested to him that since little had been written on French explorers of the Pacific, this could be a rich research area, and Dunmore took him at his word. Since the 1950s he has studied the original logs and journals of the voyages of the three great French navigators, Bougainville, Surville and La Pérouse, and these studies have resulted in 10 major academic books. The two-volume *French Explorers in the Pacific* (Clarendon Press, 1965 & 1969) is the foundation work. His scholarly editions of the journals of the three explorers have appeared under the imprint of the Hakluyt Society, London, and he has also published a detailed biography for each. A particular achievement was locating and editing the journal of La Pérouse, which had been misfiled in the French National Archives. *The Fateful Voyage of the St Jean-Baptiste*, (1969) a study of Surville's journey across the Pacific in 1769/70, gained the Wattie Book of the Year award in 1970. Most recent among his publications are Bougainville's journal (2002) and biography (2004).

The French explorer John-François la Pérouse

Related to these academic works has been a steady stream of books written for general readers, such as the wide-ranging survey *Visions and Realities: France in the Pacific 1695–1995* (Heritage Press, 1997) and useful reference works, as well as some 50 scholarly papers and reviews.

A number of Dunmore's books have been translated into French, and he was a founder, in 1980, of the *New Zealand Journal of French Studies*.

Dunmore's dedication to French culture and language has earned him special recognition from the French government. He was made a Chevalier de la Légion d'Honneur in 1976, and an Officier de l'Ordre des Palmes Académiques 1986. Following his retirement from Massey in 1984 he became an Emeritus Professor, and was awarded a Massey Medal in 1993. New Zealand recognition has included a 1990 New Zealand Medal, and in 2001 he was made a Companion of the New Zealand Order of Merit (CNZM).

John Dunmore's biography of Louis de Bougainville, *Storms and Dreams*, will be published in March 2005.

Thinking postgrad? Take the next step with Massey University.

Dan Buxton, Graduate of Industrial Design.

To get the best postgraduate education, you need to study with the best. You need a research-intensive environment which stimulates and supports you through your studies.

Massey has one of the highest research outputs of any New Zealand university across a diverse range of disciplines and is one of the top three universities for completed research degrees.

As a postgraduate student with us, you'll become part of a forward-looking research community with a track record of problem solving and an international reputation for the quality and relevance of its applied research.

We're the only University represented in all of the Government-funded Centres of Research Excellence and our significant public funding gives you access to more scholarships and excellent support. Massey also has strong links with business and the community. The Albany e-centre for example, is a highly successful incubator for new businesses.

Massey University's facilities are world class and include: the EpiCentre, the Allan Wilson Centre for Molecular Ecology and Evolution, the Research School of Public Health and the country's most distinguished School of Design.

With our campuses in Auckland, Palmerston North, Wellington and our extensive extramural programme, you have the flexibility to study wherever you are. So what are you waiting for? Take the next step with Massey University.

MAKE A DIFFERENCE Massey University

Te Kunenga ki Pūrehuroa

0800 MASSEY (627 739) www.massey.ac.nz