DID YOU KNOW?

IRL scientists are world leaders in High Temperature Superconductivity (HTS)– an emerging field transforming the way electricity is used with a global market that could be worth billions of dollars in the next ten years.

Because of its leading position, global players like Siemens and General Cable are partnering with IRL as they develop products that utilise HTS technology which will enable them to manufacture smaller, lighter and more efficient machines than can be achieved with existing copper wire technology.

Superconductivity is a phenomenon that enables the transmission of electricity without resistance or the loss of energy. IRL's world-leading position in the development of HTS is thanks to the efforts of Drs Bob Buckley and Jeff Tallon, who discovered a new type of superconducting material more than 20 years ago.

Drs Buckley and Tallon were recognised for their world-beating efforts when they were awarded New Zealand's most prestigious science award – the inaugural Prime Minister's Science Prize in 2010.

What does this mean?

It is predicted that over the next 10 to 20 years HTS technology will be adopted for a huge variety of industries and the market globally for HTS applications could be worth US$20 billion.

IRL's extensive R&D programme is providing New Zealand companies the opportunity to secure a valuable slice of this global market.

Companies in the engineering, manufacturing and power systems sectors like General Cable Superconductors, DC Ross, Fabrum Solutions, ETEL and PB Power are already reaping the benefits of IRL's 20 year research programme into HTS through the development of products that use the technology.

IRL's leading position has led to the creation of spin-off company HTS-110 Ltd, which makes high-value HTS magnets for customers around the globe. Despite the challenging business environment, HTS-110 continues to experience strong growth.

In the coming decades companies benefitting from IRL's HTS R&D programme will have the opportunity to take a stake in the multi-billion dollar global HTS market, enabling them to earn all important export revenue for New Zealand.

INDUSTRIAL RESEARCH LIMITED
Te Tauihu Pūtaiao

Contents

COVER: With the use of time-lapse photography, stars appear to circle the Earth's axis of rotation projected on the sky. This kind of long exposure is only possible from an extremely dark site such as Siding Spring Observatory, the location of the Anglo-Australian Telescope, whose building dominates the foreground. Image courtesy of the Australian Astronomical Observatory. THIS PAGE: Wellington city, New Zealand, across the harbour from IRL business unit KiwiStar Optics, is pictured at night beneath the Milky Way

Editor: Mike Eng
Contributors: Shaun Coffey, Trish Heketa, Malcolm Burgess, Glenda Lewis
Photography: Alan Wright—Shiny Blue Orb
Publisher: Tangible Media
Tangible Media Account Manager: LauraGrace McFarland (09 358-7294)
Publisher Customer Magazines: Julian Andrews (09 358-7292)

IRL Account Managers: Auckland +64 9 920 3100 Tony Cooper, Tom Rogers, Geoff Bates, Jonathan Miller
Wellington +64 4 931 3000 Tom Nicolle, Catherine Andrews, Tony Davidson
Christchurch +64 3 358 9189 John Souter
Commercial Manager: Wellington +64 4 931 3000 Gavin Mitchell
www.irl.cri.nz ISSN 1179-6073 (print)
ISSN 1179-8165 (online)

Patently obvious

The most significant changes to New Zealand's science system in two decades are now well under way as the government moves to implement the Crown Research Institute (CRI) Taskforce's recommendations.

Even as I write this editorial much of the practical detail is being worked out by officials at the Ministry of Research, Science and Technology (soon to become the Ministry of Science and Innovation) in collaboration with CRI management.

CRIs must be careful not to waste the opportunities. As is often the case with complex systems, it is one thing to point out shortfallings, but quite another to come up with workable improvements.

Exactly what benefits accrue to an economy by investing in R&D is a much-debated subject. It is generally agreed that countries which invest more public funds in R&D tend to be wealthier but the exact relationship between R&D investment and the broader economy is less well understood.

Regardless, it is important to get the best out of any public funds invested in R&D and this is clear in the objectives of the CRI Taskforce. Also clear is the need for greater collaboration within the science system and between research institutions and firms.

While New Zealand has several advantages over many other developed economies, it is disadvantaged by its small size and distance from markets. Collaboration is key to overcoming these obstacles. It is encouraging that this necessity has been highlighted by the CRI Taskforce and that the government has picked up the ball and run with it.

We just need to look across the Tasman for evidence of how collaboration spawns innovation.

My colleague, Deputy Director of the MacDiarmid Institute and IRL Distinguished Scientist Dr Shaun Hendy, cites a study by University of Waikato economist Philip McCann, that shows New Zealand collectively files approximately 40 per cent fewer patents per million inhabitants compared with our Australian neighbours.

This discrepancy is due almost entirely to the large metropolitan areas of Melbourne and Sydney, where patenting rates are significantly higher than smaller centres — the theory being that the larger the city, the more innovative it tends to be.

Dr Hendy asserts this is because bigger centres tend to have more people working in knowledge and innovation, whose disciplines are becoming increasingly specialised, thus requiring greater collaboration to make an impact.

When Dr Hendy says New Zealand needs to think and act like a city of four million, I can see a certain resonance with the changes that are being made to the science system in New Zealand. CRIs, universities and polytechnics are being asked to collaborate more closely in order to assist private enterprise in making better use of R&D investment.

CRI Boards are being reshaped to reflect this new era of collaboration and IRL is pleased to welcome University of Canterbury Pro-Vice-Chancellor (Engineering), Professor Jan Evans-Freeman, to the IRL Board. Her research interests are directly relevant to the organisation and, coupled with her experience, will ensure she makes a valuable contribution to the Board's governance.

In another major reshape of the science system, the Ministry of Research, Science and Technology is being merged with the Foundation for Research, Science and Technology to create a Ministry of Science and Innovation.

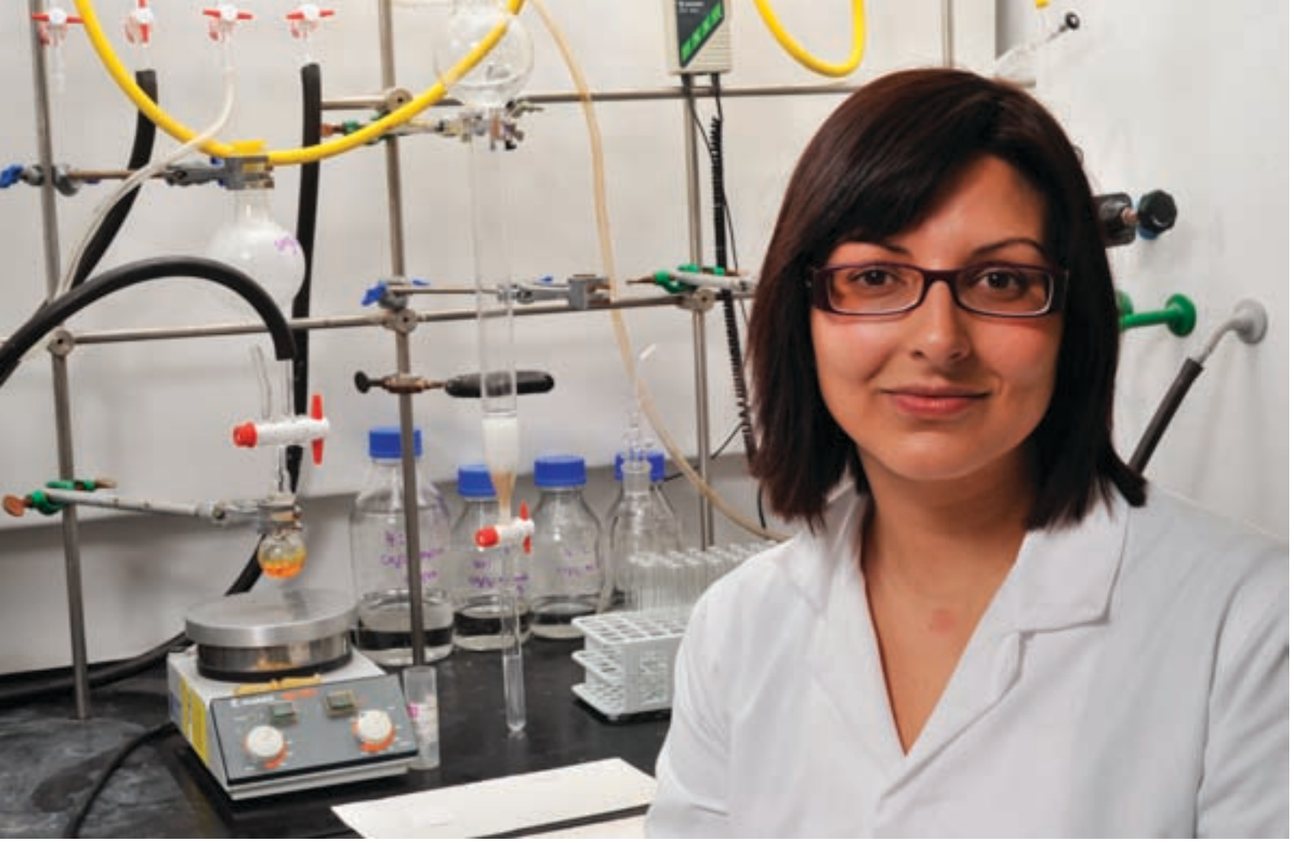
Once this happens, it will be easier for industry to get access to funding and to take advantage of the services of public R&D institutions like IRL.

Despite the constraints on Crown expenditure, additional funding was allocated to science R&D in the 2010 Budget — evidence that the government is serious about lifting our economic performance through investment in R&D.

But as always, it is up to CRIs and other R&D providers to demonstrate how R&D can improve productivity and profitability. I hope as you read through this edition of *IRL Solutions*, you come across many examples of how R&D is doing just that.

Shaun Coffey
Chief Executive
Industrial Research Ltd

New Zealand collectively files approximately 40 per cent fewer patents per million inhabitants compared with our Australian neighbours.



Big Apple ripe for picking

IRL scientist heads to the United States to work side by side with top biochemist's team.

Dr Gulab's presence in New York is expected to facilitate planning of biochemical and biological testing at Einstein of a raft of new compounds synthesised at IRL and targeted at diseases ranging from cancer to autoimmune diseases.

ABOVE: IRL research scientist Dr Shivali Gulab is off to New York's Albert Einstein College of Medicine for two years.

IRL is expanding its US presence to boost a partnership that has already created a pipeline of promising drug treatments for a range of debilitating illnesses.

IRL research scientist Dr Shivali Gulab will spend two years on site at Albert Einstein College of Medicine (Einstein) of Yeshiva University in New York City, working closely with world-renowned biochemist Professor Vern Schramm and his team.

The results of the collaboration between IRL's Carbohydrate Chemistry group and Professor Schramm's team, which began in 1994, to date include a number of potent enzyme inhibitors that have now progressed to late stage human trials under license to a US company. The first compound targets T-cell mediated cancers, and results of pivotal Phase 2b human clinical trials are due out at the end of this year. The second compound has shown exciting results in patients with gout, a painful disorder affecting millions of people around the world. Other highlights from the collaborations between IRL and Einstein include drug candidates for malaria and for a range of major cancers that are currently in preclinical testing.

Einstein is one of the largest medical schools in the US, with the National Institutes of Health providing more than US$155 million in funding to its faculty members in 2009, in addition to funding major research centres in diabetes, cancer, liver disease and AIDS.

Dr Gulab will have some big opportunities to raise the profile of IRL through her work at Einstein. In Professor Schramm's laboratories she will continue her cutting-edge carbohydrate chemistry, synthesising potential inhibitors for enzymes involved in a range of illnesses. "At the moment I'm working on inhibitors for the enzyme nicotinamide phosphoribosyltransferase (NAMPT), a promising anticancer target," she says.

Her presence in New York is expected to facilitate planning of biochemical and biological testing at Einstein of a raft of new compounds synthesised at IRL and targeted at diseases ranging from cancer to autoimmune diseases. She will also forge increased connections with other world-leading groups at Einstein involved in microbiology, immunology and genetics.

Dr Gulab is skilled at communicating science to potential clients, so once her laboratory projects are well under way, she will work with IRL's US-based account manager Richard Lauricella to connect to a broader commercial audience interested in IRL's services.

EXERCISE IN INVENTION

A computer-aided rehabilitation device is lauded for helping to combat paralysis.

An IRL-developed exercise device that helps the brain injured recover movement in their arms has won a top Australian technology award.

Able-X won first prize in the prototype category of the 2010 Engineers Australia College of Biomedical Engineering Better Technology Awards.

Developed by the Christchurch-based Assistive Devices team, it has shown promising results in clinical trials and will go to market later this year.

Able-X, which is now being commercialised through Wellington-based partner company Im-Able, is a suite of specially designed computer games with a bilateral exercise device.

It allows a person with an arm disability, resulting from neurological injury, to exercise their limb while playing engaging games.

"It was a very special feeling to be recognised by our scientific peers for excellence in this field," says programme leader and research engineer Marcus King.

"This award gives credibility to our research and shows that we are leading the way in rehabilitation science – an essential requirement for securing future funding."

Able-X can be used by people across a broad spectrum of disability, from those who are severely paralysed to those who are almost fully able-bodied.

There have been promising results from clinical trials undertaken at the University of Otago's Rehabilitative Exercise and Activity for Life Neurology Research Group.

"We've had reports that people who have one paralysed arm and have been having to drive their car single-handedly can now use both hands on the steering wheel at once," says King.

A market release is planned for late 2010 for Able-X, which was developed in collaboration with Christchurch-based companies Stickmen Studios and Pukka Design Studio. It incorporates an inertial sensor game console developed by Taiwanese-based IRL collaborator the Industrial Technology Research Institute (ITRI).

The award was presented at the recent Australian Rehabilitation and Assistive Technology Association's National Conference in Hobart, at which Marcus spoke about his work.

"We've had reports that people who have one paralysed arm and have been having to drive their car single-handedly can now use both hands on the steering wheel at once."

ABOVE: The Able-X exercise device has shown promising results in clinical trials.

Cutting-edge science rewarded with new funding

The spotlight is on IRL's work in emerging disciplines in this year's main Foundation for Research Science and Technology (FRST) funding round, reflected by the four programmes which have recently been successful in their funding applications.

With new funding of $300,000 pa for three years, nanorod materials are being used to develop an innovative microscope with superior technical performance, including the 3D imaging of material stiffness within a product.

Building on an established knowledge platform, a programme to develop new techniques to control nanocrystal growth for applications in materials where nanoscale shape control is crucial – such as nanomaterials for energy and food – has received $1.2 million over two years.

A programme pioneering a step change in the premium coatings industry has received $440,000 pa over four years to develop paints and waterborne surface coating ingredients made from renewable resources.

Funding of $350,000 pa for three years will also assist in the development of a new high efficiency electrolyser which will use hydrogen in remote power systems and make hydrogen energy a cost-effective option to meet the demand for flexible renewable energy systems.

A large portion of FRST's investment funds are awarded to research organisations – Crown Research Institutes, universities and private research companies – that conduct public good, science and technology (PGST) research projects of benefit to New Zealand.

These funds are heavily contested, with FRST receiving 88 PGST concepts in the 2009/10 funding round. Of those, only 15 successfully reached the proposal stage and were approved for contracting.

Post-doctoral researcher Dr Nicole Miller

CARBS ON THE MENU

Glycoside compounds used in drug discoveries are being made by GlycoSyn and sold online around the world.

Cutting-edge academic research with powerful implications for medicinal chemistry is finding its way to the global market thanks to a collaboration between IRL business unit GlycoSyn and Auckland University's research arm, UniServices.

For the past few months, post-doctoral researcher Dr Nicole Miller has been leveraging GlycoSyn's world-class carbohydrate chemistry expertise and scale-up facilities in an NZTE-funded project to synthesise high-value, hard-to-produce compounds known as glycosides for sale through GlycoSyn's Australian joint venture, Mimotopes.

Glycosides – conjugates between an amino acid and a sugar – are the key building blocks for the synthesis of glycopeptides, which are naturally occurring compounds that play critical biological roles in functions such as cell signalling, neuronal development and the human immune system, says Dr Miller.

These building blocks are sought after by molecular biologists, protein chemists, immunologists and medical doctors. However, a jumble of different mixes of sugars within the same molecule mean they are notoriously hard to isolate from natural compounds, making it difficult to figure out which compounds are most important.

"With our readily available compounds, biologists can easily determine the necessary glycosylation pattern required for biological activity. We deliver a synthetic platform that other researchers can use to mimic nature and to develop synthetic drugs," she says.

Dr Miller, who studied in Ulm and Heidelberg, worked with Dr Margaret Brimble's world-renowned organic and medicinal chemistry group at Auckland University for two years on the synthesis of glycopeptides and neoglycopeptides before joining the project with GlycoSyn's senior process development chemist Dr Peter Kelly in Lower Hutt.

"In Auckland we were already working with these compounds so we know it is an interesting market to develop them on a larger scale."

GlycoSyn account manager Dr Tony Davidson describes the project as one that takes research out of the lab at Auckland, leads it through the commercialisation pathway at GlycoSyn, and delivers a high-value end product through the Mimotopes website, a large player in the peptide space with a long track record and large client list.

"Utilising both the expertise of the Brimble group in peptides and the experience at GlycoSyn in scaling up carbohydrates has allowed the development of several high-value glycopeptide intermediates," he says.

The first batch of glycopeptide intermediates have already been shipped and can be purchased via the Mimotopes website, www.mimotopes.com.

MĀORI INDUSTRY STRATEGY SET TO GO

Research and outreach fellowship key part of plan to enhance Māori business interests.

IRL is seeking to boost the profitability and productivity of Māori-based industry through the implementation of its recently developed Māori Industry Strategy.

IRL General Manager Industry Engagement and Deputy CEO Drew Stein says IRL's wide-ranging R&D capability is well placed to serve many key industries in which Māori commercial interests are active.

"Because IRL works across so many sectors, from agriculture and forestry to high-tech manufacturing, natural product development, future energy solutions and pharmaceutical development, we believe that we have much to offer Māori business interests across the board."

The strategy will build on existing relationships including one with Fomana Capital, the investment arm of the Federation of Māori Authorities, which was formalised under an accord in 2008 when the two parties agreed to jointly develop high-value nutraceutical and cosmeceutical products for global markets.

IRL's Integrated Bioactive Technologies team is currently working with Māori organisations on five R&D projects which are mainly in the natural products area.

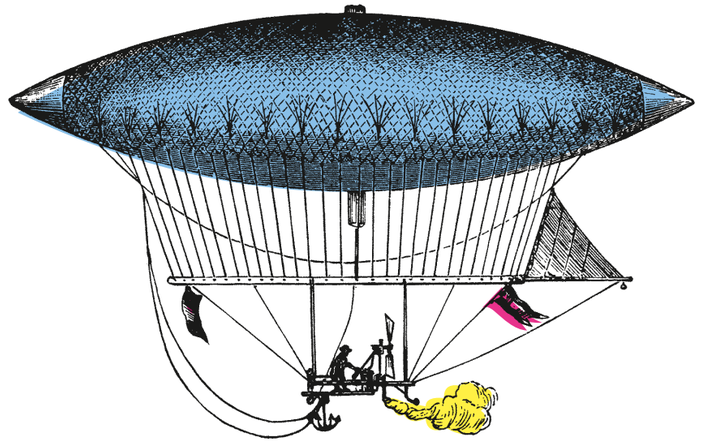
The implementation phase of the strategy will begin its rollout later this year after a market segmentation study which will be conducted to establish precisely where IRL should focus its resources.

RIGHT: Sony Davis carves Te Tauihu Pūtaiao (waka prow) which symbolises IRL's vision of cutting-edge science.

A key plank of the strategy will be the establishment of a Māori fellowship, whereby scientists or engineers will be funded to undertake an agreed research programme for Māori enterprises in conjunction with IRL.

IRL account manager Māori Engagement Tom Rogers says he is excited about the opportunities that lie ahead.

"Partnerships with IRL will create new opportunities to grow and develop the asset bases of Māori organisations, increase revenues and improve shareholder wealth. These benefits will, in time, flow on to iwi and hapū across the country."



Help getting good ideas to fly

IRL's dollar-for-dollar product pathway.

A new programme designed to assist businesses to get products to market with much lower development costs has recently been launched by IRL.

The Co-investment Programme will provide businesses with the opportunity to use IRL technology to develop research ideas into prototypes and proofs of concept at a heavily discounted rate.

IRL's commercial manager Gavin Mitchell says the programme will allow companies to assess new ideas without significant impact on other development and marketing costs and will enable the validation and creation of new IP.

"Businesses now have the opportunity to 'de-risk' the innovation process by sharing the risk with IRL to assist them in bringing new ideas to production."

Despite development grants being made available by government, many businesses cannot get new ideas off the drawing board because they are unable to fund the initial research and development of a prototype necessary to prove the value of the idea and secure grants.

Under the new programme, businesses will contribute only half the costs of the prototype or proof of concept, and those proposals that meet IRL's selection criteria will receive a dollar-for-dollar contribution from IRL.

In addition, selected companies will have the opportunity to showcase successes and enhance their profiles in front of political, science and other stakeholders at a celebration dinner in October.

Successful proposals that are deemed outstanding may also be awarded prizes over and above the initial funding.

"Businesses now have the opportunity to 'de-risk' the innovation process by sharing the risk with IRL to assist them in bringing new ideas to production."

Meat and compete

Robots designed in partnership with IRL could save millions in meat processing costs.

A project to develop automated meat processing technology is setting a new standard in efficient and effective research, development and commercialisation.

IRL, together with Realcold Milmech, is a lead research partner in the $15m million project, which began just over a year ago and will save the industry millions of dollars by automating the early stages of sheep processing. The initiative is funded by nine meat companies that have banded together to form Ovine Automation Limited (OAL), and the Foundation for Research, Science and Technology.

The project is ahead of schedule with trial technology installed in plants in both the South and North islands. Equipment developed so far by IRL includes a pilot leg roller, a gas de-pelter, which uses pressurised gas to release pelts from carcasses, and an intelligent Y-cutter robot. The Y-cut is an industry term for the cut that opens the fleece on the front legs of a sheep in preparation for pelt removal.

Realcold Milmech has two robots, dubbed Alice and Rita by staff on the plant floor, operating in production at a Southland plant to automate brisket cutting and remove the internal organs of sheep. Other robots will be installed further down the track.

The system is modular, with equipment expected to be progressively released for sale from early in 2011.

Geoff Bates, IRL account manager Engineering & Applied Physics, says being adequately funded, thinking laterally, and collaboration with plenty of industry partner input, have been central to the success of the project.

"With previous automation R&D for the meat processing industry, we've tended to pick the hardest jobs and underquote on the cost. Kiwis are always trying to do things for as little as possible but ultimately it is cheaper to invest $300,000 and end up with a working product than to invest $100,000 and end up with nothing."

Rather than building robots from scratch, the project partners are purchasing basic units ready-made, and putting the creative effort into inventing the components needed for the specific job in mind. They're also being pragmatic, says Bates, and automating only the parts of the process that can be done better by machines.

But the way the industry and R&D partners are working together is arguably the most stand-out feature of the project.

Realcold Milmech R&D manager Peter Loeber says in more than 30 years in the meat processing industry, he has never before seen such a degree of cooperation.

"Everyone has put aside differences and is contributing their ideas and skills, right down to those actually doing the processing. For them, installing robots has meant a new layout and doing some things differently but the changes have been met with willingness and a positive attitude."

OAL manager Richard McColl agrees, saying the institutional knowledge of people in all parts of the industry is being harnessed and fed into the R&D.

"IRL, for example, has been able to work alongside production and engineering staff from within meat processing plants for the first time, solving problems collectively and ensuring that what they come up with will work in the plant."

"Kiwis are always trying to do things for as little as possible but ultimately it is cheaper to invest $300,000 and end up with a working product than to invest $100,000 and end up with nothing."

The automated meat processing technology includes a pilot leg roller, seen here installed on a static test rig at Auckland Meat Processors in South Auckland. Pictured, from left, Jason van Beurden (IRL), Geoff Bates (IRL), Chris Stiles (AMP), Eddie Moore (AMP), Chris Lennox (IRL).

STOMACH FOR SUCCESS

Americans embrace unique wound-healing technology formed out of meat processing waste.

Another spin-off from IRL's work with Mesynthes is the demonstration of the wound-healing benefits of a peptide and a protein extract from sheep tissue which are being studied for their healing properties.

ABOVE: Dr Brian Ward heads Mesynthes Limited which has developed a collagen-based tissue subsitute from sheep stomachs.

A former vet and IRL scientists have teamed up to convert sheep stomachs into a ready-to-use collagen-based tissue substitute that is poised for international success.

Wellington-based Mesynthes Limited, headed by former vet Dr Brian Ward, has developed Endoform, which is made from the extracellular matrix (ECM) of sheep stomachs.

Components within the material have been shown to speed up healing and stimulate regrowth of the recipients' own tissue. Mesynthes' first product gained approval from the United States Food and Drug Administration (FDA) earlier this year.

Made up mostly of collagen, the ECM is the host environment for cells and holds the signals that direct cells to divide, differentiate and organise themselves into a specific form. Dr Ward had seen its potential for regeneration and healing during his years working as a veterinarian and in healthcare companies around the world.

IRL's Dr Keryn Johnson was Dr Ward's ideal scientific partner. Since 2001, Dr Johnson and his team have been researching how to extract beneficial components from the ECM as part of a project with Meat and Livestock Australia to convert meat processing waste into high-value bioactive products.

Dr Johnson's expertise in analysing and processing tissue from the ECM proved invaluable.

"We began by testing both bovine and ovine tissue but within a week could see that sheep tissue was easier to work with and produced larger sheets of material," says Dr Johnson.

The speed with which IRL was able to deliver results was crucial for Mesynthes, which was working to tight time frames to produce results.

Within a week, Dr Johnson's team had progressed from cutting sheets of tissue to processing whole organs by inflating them in what was effectively a dialysis bag to optimise extraction of the raw material.

IRL has helped Mesynthes identify and better understand the biological components in its products and fine-tune a device for separating the ECM from the sandwiching layers of muscle and epithelial cells.

More recently, IRL helped the company develop a commercial scale manufacturing process which uses biomimicry, in which the natural properties of the tissue are harnessed to aid its processing.

Mesynthes is located on IRL's Gracefield campus and Dr Ward says the proximity to IRL staff and facilities has helped the company achieve its milestones and growth targets.

"But primarily it was the calibre of the science that gave us a huge leap up."

The Crusader Engineering team

Clip-on crusaders

East Tamaki mechanical process engineering company Crusader Engineering likes achieving the impossible.

When super-massive 50-tonne trucks were about to hit the road a few years ago, some quick calculations showed that if they were to end up nose-to-tail and stationary on Auckland Harbour Bridge – not a totally unlikely scenario – the clip-on lanes could well collapse. Trucks were immediately banned from the outside lanes, and a tender was put out to strengthen the clip-ons with an estimated 350 tonnes of steel.

The then-small mechanical process engineering company in East Tamaki, Crusader Engineering, won the contract, and the number of hard hats in the factory tripled in two years. Over 900 tonnes of steel were needed, supplied as over 20,000 individually numbered pieces, and made to within incredibly tight tolerance limits of 0.25mm – the sort of precision that makes the thickness of a coat of paint critical. Fluctuating temperatures, plus traffic and wind force, can significantly expand and flex the steel, presenting all sorts of three-dimensional engineering difficulties.

The company spent $1 million gearing up for the job, and was given just a month following the successful tender to prove itself. The job has been completed and the trucks are now rolling.

Before the mammoth bridge project, Crusader Engineering built a medical waste sterilisation plant for Wellington. When overseas designers proved unable to supply the facility inside 18 months, Crusader rose to the challenge of designing, building and commissioning the plant within six months. They also solved some operational issues the client had with previously imported designs.

The company's main business, however, is still timber treatment processing. Their process allows the timber to be treated after it is machined to its final shape and form, and no chemically contaminated sawdust is generated. The addition of a water repellent improves stability and quality – attributes New Zealanders will be mindful of after the appalling misery suffered by leaky home owners.

Crusader's big advantage is its ability to remove and recover the solvent, eliminating the health risks of volatile organic compounds. The team use radio frequency technology to drive off the solvent, which can then be re-used, with obvious economic benefits. And the product can be ready for market and out of the factory much faster, reducing storage time and space. The company, which is eager to export this dramatically improved process, has a large pilot plant in the US. IRL chemical engineers Drs Stephen Tallon, Peter Dyer and Wayne Eltringham are working with Crusader's designers to make this plant as efficient as possible.

There are exciting possibilities ahead. The principle of using radio frequency radiation has potential applications to all sorts of other processes, such as drying animal feed.

Managing director Peter Snoad and business development manager Craig Apps say they like nothing better than to prove people wrong when they say something can't be done. They attribute their problem-solving success to the cross-pollination of diverse engineering backgrounds they have on staff ("old heads and young stars"). And the company is still small enough, says Craig, that everyone can have a voice, and feel that their opinion really counts.

Over 900 tonnes of steel were needed, supplied as more than 20,000 individually numbered pieces, and made to within incredibly tight tolerance limits of 0.25mm – the sort of precision that makes the thickness of a coat of paint critical.

ABOVE: The iconic Auckland Harbour Bridge.

Eye on the heavens

IRL business unit KiwiStar Optics helps to unravel the 12-billion-year history of our galaxy by producing optical cameras for the Australian Hermes project.

New Zealand's place in the global astronomy family has become further established with a multi-million dollar contract to produce precision optical components for Australia's largest telescope, the 3.9m Anglo-Australian Telescope (AAT) at the Siding Spring Observatory in New South Wales.

The contract stems from a long-standing collaboration between IRL business unit KiwiStar Optics and the Australian Astronomical Observatory (AAO), a division of that country's Department of Innovation, Industry Science and Research. It is part of an ambitious AAO project called Hermes, named after the Greek messenger of the Gods, which will provide a unique and powerful new facility for multi-object astronomy.

Over the next four years the primary Hermes science project, the Galactic Archaeology Survey, aims to unravel for the first time the 12-billion-year history of our galaxy, the Milky Way. Of particular importance is the identification of the early activities of primordial stellar fragments that are believed to have been the founding blocks of our galaxy.

The Hermes system includes a powerful new spectrograph which will be capable of collecting the light from 400 stars at a time. This is a vast improvement over traditional spectrographs, which can typically analyse light from only one or two objects simultaneously. The high-resolution Hermes spectrograph will be used to capture spectral images of over a million stars.

The head of Mechanical Engineering at AAO, Greg Smith, says the Hermes project is unique in terms of its spectral resolution and ability to look at multiple objects at the same time.

"Extragalactic surveys using the Hermes spectrograph will be the flagship science for the AAT over the next few years. Based on our previous work with KiwiStar Optics, they were an obvious choice to help us create this ground-breaking tool."

Astronomical spectrographs split the light from a celestial object into a spectrum of colours, in much the same way as a prism does. From this, scientists are able to determine important properties such as the chemical composition and velocity of the object, revealing vital facts that photographs cannot show.

KiwiStar Optics is building some of the main spectrograph components, which work together as one system. The four optical cameras – red, blue, green and infrared – and a collimator, composed of a mirror almost one meter in diameter and two large lenses, will require specialist optical design and fabrication, says technical project manager Peter Connor.

"Each camera consists of five large glass lenses, the largest being 380mm in diameter, that weigh a total of 100 kilograms.

"All the glass, including that in the collimator, must be polished to an extremely precise surface curvature which is accurate to within one wavelength of light. This is less than one thousandth of a millimetre, or about 200 times smaller than the diameter of a human hair."

IRL's Measurement Standards Laboratory will provide the measurement expertise to ensure all the lenses are precisely aligned. With Auckland company kanDO Innovation designing the camera housings, and IRL's Engineering Innovations team and Mechanical Workshop designing and building the mechanical parts of the collimator and the housings, the project is also supporting precision manufacturing industries in New Zealand.

Each component will be sent to the AAO laboratory in Sydney to be assembled into the spectrograph and tested, then to Siding Spring to be installed in a custom-built room adjacent to the AAT.

"Hermes is a spectacular and extremely ambitious project," says Peter Connor. "It's another example of the very innovative approach to astronomy in Australia, and it's good to be a part of it."

Astronomical spectrographs split the light from a celestial object into a spectrum of colours, in much the same way as a prism does.

LEFT: The new Hermes spectrograph will be used to capture spectral images of over a million stars in the Milky Way (pictured). ABOVE: Graeme Jonas, KiwiStar optical engineer, machine-polishes a spectrograph mirror.

About KiwiStar Optics

With a 40-year record in optics research and development in New Zealand, the KiwiStar team has built up a worldwide reputation in optical design and manufacture. KiwiStar's optics are installed in telescopes in Australia, Hawaii, South Africa and at the University of Canterbury's Mt John Observatory near Tekapo.

Other lenses can be found in a sophisticated navigation system at the Diego Garcia US naval base in the Indian Ocean and a special camera for a proton radiography experiment at Los Alamos National Laboratory in the US.

Now, with funding from FRST and co-funding from Agmar Engineering Tools Ltd, they are to produce a high-resolution spectrograph for small- to medium-sized telescopes at an affordable price as the basis of a new export industry for New Zealand.

HTS-110 wired for success

IRL spin-off company making high-temperature superconducting wire engages WelTec to scale up production for overseas clients.

"HTS is a cutting-edge discipline in which there is still much to be understood. We are one of the few companies in the world that make added-value commercial products using HTS."

HTS-110 Ltd has teamed up with Lower Hutt-based Institute of Technology, WelTec, to enhance the production of its in-demand magnetic products.

The IRL spin-off company develops magnetic solutions using high-temperature superconducting (HTS) wire for a range of industrial applications around the world.

It has recently had to take on new staff to cope with repeat orders from satisfied industrial and academic customers in Asia and the US.

HTS technology enables the conduction of electricity without resistance or the loss of energy and can be used in the development of smaller and more efficient machines than can be achieved with existing copper wire technology.

It can also be used to generate very strong magnetic fields such as those required in Magnetic Resonance Imaging (MRI) machines in hospitals as well as Nuclear Magnetic Resonance (NMR) analysers, which accurately analyse the chemical composition of materials.

HTS-110 product manager Tijs Robinson says WelTec will play a crucial role in enabling the company to meet future demand

"The HTS magnet industry is so specialised that until recently we've been concentrating on customised units built to the specifications of clients.

"WelTec's expertise in scaling up production will be invaluable as volumes grow. We have been working closely with WelTec to look at specific product lines where we are seeing the most growth. We will be incorporating these learnings into product design and processes so that we can manufacture high quality products more quickly, cost effectively and accurately."

Tijs Robinson says while the steep growth curve represents an opportunity, it also poses significant challenges.

"Because this is such a step change in our growth we need to make sure we are able to stay ahead of the curve without compromising in performance and quality – areas that are critical to our success to date."

Also key to staying ahead of the curve is the continuing research into HTS technology at IRL.

"HTS is a cutting-edge discipline in which there is still much to be understood. We are one of the few companies in the world that make added-value commercial products using HTS, and staying at the forefront is helped by continued innovation from IRL's HTS platform. We are clear that part of our future competitive advantage will be due to their continuing research programme," says Robinson.

WelTec Chief Executive Dr Linda Sissons is pleased that companies such as HTS-110 benefit from WelTec's capability.

"WelTec's applied research capability assists companies to exploit their export potential, apply new processes or make organisational adjustments arising from the impact of new technologies. The provision of services like this, that connect expertise with specific needs, makes it easier for companies to take advantage of knowledge, applied research and technologies that would otherwise not be open to them to exploit," she says.

HTS-110's expertise was on show in August at the WelTec, GNS and IRL Innovation and Technology Expo in Wellington.

University challenge

Dr Rod Carr, member of the CRI Taskforce and Vice-Chancellor of the University of Canterbury (UC), examines where universities fit in the 'big picture' of national science infrastructure.

The CRI Taskforce's report "How to enhance the value of New Zealand's investment in CRIs" has officially moved to implementation phase, so it's time to consider practical ways to bring its recommendations to life. The changes proposed include re-alignment of governance and funding structures, a focus on collaboration between agencies and a move from concentration on individual CRI bottom lines to economic, social and environmental dividends for New Zealand. From a university standpoint, some progress is under way, with excellent scope for closer collaboration. Let's look at a few of the new and potential developments.

At the governance level, the government has already moved to add to some CRI boards appropriately experienced senior university personnel. UC's Pro-Vice-Chancellor (Engineering) Professor Jan Evans-Freeman and Assistant Vice-Chancellor (Research) Professor Steve Weaver have recently joined the Boards of Industrial Research Limited (IRL) and the Institute of Geological and Nuclear Sciences Ltd respectively, while Associate Professor Wendy Lawson has been on the board of the National Institute of Water and Atmospheric Research for some time. Catherine Drayton, a board member at IRL, is also a member of the University of Canterbury Council. Cross-appointments like these will help the collaborative approach to be enshrined in the new statements of strategic intent in development by CRIs.

Examples of successful joint research projects between CRIs and universities include the collaboration between UC and Geological and Nuclear Sciences on the development of a hazards platform, and joint teaching and research into wood properties by UC and Scion researchers. For example, a senior scientist in Scion is also an adjunct senior fellow at UC's School of Forestry. A joint research project into Stirling engines and cryocoolers was carried out for a number of years between IRL and the Mechanical Engineering department, and new projects are currently being planned.

One of the roles of universities such as UC is to ensure a pipeline of quality scientists to meet CRIs' future needs. We have experienced a recent upsurge in interest in science subjects to the point where UC is currently 109% enrolled in the College of Science relative to its Tertiary Education Commission funding allocation. We are already experienced in managing the work-integrated learning requirements of professional degrees such as engineering and education and are keen to explore with CRIs the opportunity for internships or other work-integrated experience for quality science students.

We can also look into the co-location of facilities and common equipment and laboratory space. The Institute of Environmental Science and Research premises adjacent to UC, the state-of-the-art School of Biological Science building scheduled to open in October 2010 and the 20-year master plan in development for the campus create the opportunity to plan and equip for the longer term and the greater good. This kind of approach reflects the "big picture thinking" about national science infrastructure referred to in the taskforce report, to which we must commit time and resources to avoid duplication and fragmented effort.

The CRI Taskforce described the CRIs as a "rich repository" of scientific capability. New Zealand universities as a whole, and UC in particular, have always recognised this fact. With the change in the CRI landscape we are gearing up to explore all our options to realise the benefits of greater collaboration.

One of the roles of universities such as UC is to ensure a pipeline of quality scientists to meet CRIs' future needs.

Eye on the heavens

Steve Gibson, PhD student with KiwiStar Optics, examines an echelle grating – used in astronomical spectrographs to analyse starlight (see story Page 12).