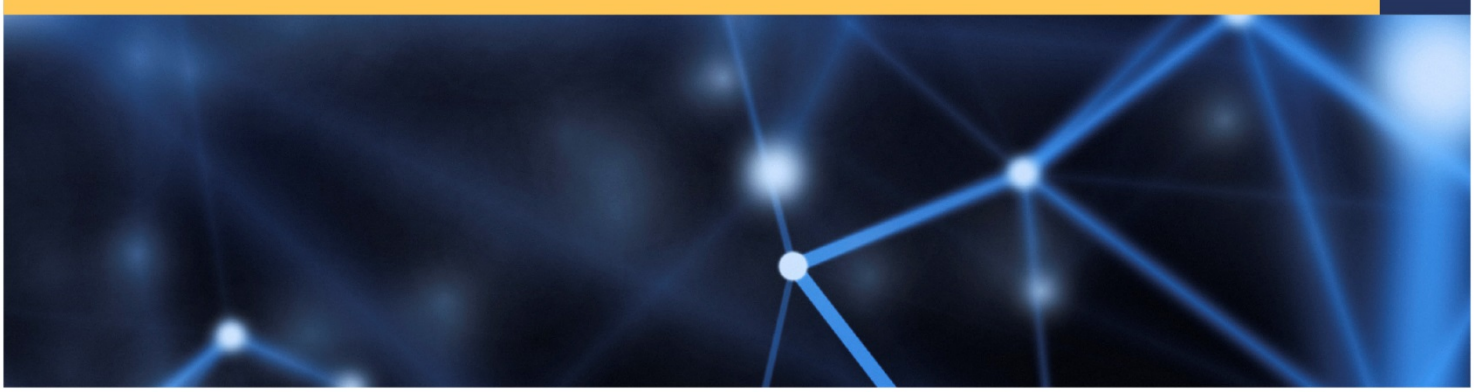
Case studies on university-business collaboration

Review of Research Policy and Funding Arrangements

November 2015



ISBN
978-1-76028-510-4 [PDF]
978-1-76028-511-1 [DOCX]

Table of contents

Introduction

This document has been compiled as part of the Review of Research Policy and Funding Arrangements undertaken for the Australian Government in 2015.

As part of the review consultation process, universities were invited to submit case studies to highlight particularly productive relationships they had cultivated with end-users of research. The review received 48 case studies from 32 universities. These involved collaborations across medical, agricultural, aerospace, manufacturing, mining, oil and gas and automotive industries.

The content of each case study in this volume was provided by the university concerned and with the consent of each university.

Bond University — Collective Bargaining in the Agricultural Sector

Partners or end-users: Government and Rural Industry

Sector: Statutory Authority and Private Industry

Sources of Support: Rural Industries Research and Development Corporation (RIRDC)

Lead researcher: Professor William van Caenegem

Funding: $80,000 (Global Challenges) and $79,500 (Collective Bargaining Project)

Duration: 18 months and four months, respectively

Outputs: Collective bargaining report, leading to the publication of an industry policy paper

Executive Summary

The Collective Bargaining Project was an initiative of RIRDC's National Rural Issues program, designed to inform various local and government stakeholders on Australia's rural industries. Bond University researchers worked with three local industries across four Australian States — dairy, chicken rearing, and plant growing — to examine the range of experiences, perceptions and understanding of the collective bargaining process between farmers and buyers, and the factors that enhance or inhibit collective bargaining.

The industry specific knowledge and contacts provided by RIRDC and the Department of Agriculture were invaluable in the conduct of this research. They ensured accurate targeting of industry sectors and potential interviewees and contributed to the factors considered by the research team in constructing the interviews used during fieldwork for the project.

RIRDC released a report of the project findings on 5 August 2015, and it generated intense interest in farming circles and the farming press. The findings and analysis of this study were aimed at a wide readership that included policymakers in the agricultural, food and regional development sectors; peak and representative farming bodies and other business organisations; regional development agencies; as well as agricultural producers, processors, distributors and retailers in the food sector.

The success of this project was directly related to the shared commitment toward translational research — to achieve both practical and policy outcomes of benefit to the rural sector and the broader economy.

Purpose of Project

RIRDC's National Rural Issues program delivers research to inform industry and government leaders on policy and practical implications of challenges in the operating environment of Australia's rural industries. As part of that program, the Collective Bargaining Project was developed to explore the uptake and effectiveness of collective bargaining in agriculture, and in particular what if any are the barriers to greater use of collective bargaining arrangements by farmers. Further, the Project sought to identify practical ways of

supporting farmers to use collective bargaining to capture a greater proportion of the retail value of their product and reduce transaction costs.

Its objectives were to:

1. Identify factors that influence the uptake and positive outcomes for collective bargaining.
2. Highlight prominent issues, terms and conditions for farmers to bargain on.
3. Consider the ways in which relevant information, communication and expertise can be disseminated most effectively to farmers.
4. Explore amendments or improvements to rules and processes affording access to collective bargaining for farmers.
5. Assess the most effective organisational structures that can be deployed by farmers to increase the likelihood of successful collective bargaining outcomes.

Scope and Method

Professor van Caenegem, the lead researcher, and his colleague Dr Cleary had led a previous Global Challenges study for RIRDC on the potential benefits for Australian agriculture of a domestic food GI regime: *Provenance for Australian food products — is there a place for Geographical Indications?*

This research involved 172 interviews across a considerable breadth of industries including: beverages (wine, tea, whiskey, spirits, liqueurs, coffee); dairy; fish and seafood; fruit, vegetables, pulses, seeds and nuts; grasses and fungi (sugarcane, truffles, mushrooms); and livestock industries.

Prior to data collection for this new research, the team conducted a literature review and used this as a basis for discussions with the commissioning body (RIRDC) and representatives from the Commonwealth Department of Agriculture on the range of factors to be taken into account in their research.

Three industries were chosen — dairy, chicken rearing and plant growing — where farmer bargaining collaboration with buyers has been higher than in other agricultural industries. The focus industries investigated were located across Queensland, Victoria, South Australia and Western Australia.

Interviews were also conducted with stakeholders in a broad range of agricultural industries with limited collective bargaining uptake including livestock industries (beef, poultry, sheep — meat and wool), dairy, plant growing, fruit, vegetables, grains, and sugar. The prior work on the domestic food GI regime was instrumental in facilitating additional interviews for the new research.

The team conducted roughly 60 interviews across value chain participants in the focus and other agricultural industries, peak bodies, support agencies and regulatory bodies, to examine the range of experiences, perceptions and understanding of the collective bargaining process, and the factors that enhance or inhibit collective bargaining.

A significant governance element for the collective bargaining project was the RIRDC-established Project Steering Committee, which met initially with the research team and relevant stakeholders in Canberra. It helped to confirm the research methodology and

ensure consistency of expectations regarding outputs, and provided feedback to assist the researchers in finalising the report.

Relationship to Industry

The industry specific knowledge and contacts provided by RIRDC and the Department of Agriculture were invaluable in the conduct of this research. It ensured accurate targeting of industry sectors and potential interviewees. To build on these contacts, the team used 'snowball' techniques during fieldwork which allowed interviewees to nominate others who had been influential in fostering collaboration, or who had been an agent for specific collective bargaining negotiations.

The research team brought extensive experience in law and regulation to the project, demonstrated experience in the conduct of in-depth interviews with farmers and stakeholders in the farm sector (from an earlier Geographical Indications project), academic expertise in the operation of the Competition and Consumer Act 2010, in-depth knowledge and understanding of competition law and policy, and expertise in the contemporary analysis of national and international agricultural policy.

Details and Analysis of Impact

The final project report was accepted and published by RIRDC on 5 August 2015. Released as part of a series of reports from RIRDC's National Rural Issues program, the collective bargaining research has helped drive the development of a pilot program identified in the Australian Government's $4 billion Agricultural Competitiveness White Paper.

Operating as a two year pilot from 2015-2016, $13.8 million will be provided by the Government to RIRDC to develop and deliver training materials on establishing cooperatives, collective bargaining, and attracting external investment and competing more effectively in the supply chain.

The Report was also timed to roughly coincide with the release of a number of Reviews of the Competition law: the Harper Review and the Competitiveness Review.

Recommendations

This research outlined five key recommendations:

1. Fully investigate the potential of a 'Cooperatives Lite' regime and the potential of other collaborative vehicles for the purpose of facilitating collective bargaining.
2. Development of a collective bargaining factorial matrix for farmer self-evaluation of opportunities for sustained success.
3. Development of a set of a priori conditions and supporting protocols to govern or influence collective bargaining conduct in agriculture.
4. Provide training in leadership, bargaining and negotiation skills to farmers who will represent farmer groups, or support the procurement of such expertise.
5. Development of an information dissemination strategy involving industry groups.

Conclusion

Effective collaboration with the funding body was a critical aspect of the project.

The findings and analysis of this study were aimed at a wide readership including policymakers in the agricultural, food and regional development sectors; peak and representative farming bodies and other business organisations; regional development agencies; as well as agricultural producers, processors, distributors and retailers in the food sector.

The contents and recommendations of the Report found resonance amongst the farming and farm industry communities and triggered further debate at a policy level. The report also generated considerable interest in the general and rural press including AM Radio interviews and reports (2), FM Radio interviews and reports (4) and Newspaper articles (13), further triggering interest in various cooperative vehicles for collective action amongst farmer groups. Public debate led to greater understanding of the many forms of collective action open to farmers, whether corporate and non-corporate vehicles (e.g. cooperatives, bargaining associations).

Some of the recommendations of the Report have been actioned, in particular developing and distributing a factorial matrix for farmers that match local conditions and requirements for optimal organisation forms (e.g. cooperatives, corporations, unit trusts, and bargaining groups).

One of the principal recommendations of the Report was the use of cooperatives as vehicles to support collective bargaining, thereby shielding farmer groups from the effect of the cartel provisions of the Competition Law. As a result of this recommendation, government bodies and agricultural industries have worked together to provide better support and advice for farmers.

Central Queensland University — 10,000 Steps to Better Health

Chief Investigator: Associate Professor Corneel Vandelanotte

Step your way to a healthier life. Sounds simple doesn't it? Nonetheless, that is the reality that the 10,000 Steps program, a physical activity concept, has well and truly proven.

From its humble beginnings in Central Queensland in 2001, the 10,000 Steps project is now recognised as an effective local health promotion activity both nationally and internationally. Its resources and research have been adopted worldwide with similar projects now in countries such as Canada and Belgium. This adoption continues to grow and grow.

Coupling the 10,000 Steps message; taking 10,000 steps every day is good for your health, with Australia's National Physical Activity Guidelines (which recommend accumulating 150 to 300 minutes of moderate intensity physical activity each week), the effectiveness of the project is evidenced by the ongoing support of different levels of government, as well as the ever increasing number of individuals and communities embracing the concept.

Together these members log 4.3 million steps on the program's website every day while undertaking an Individual Steps Challenge or participating in a Workplace Steps Challenge.

The concept is indeed a simple one. The aim is to increase the day-to-day activity of individuals by encouraging the use of a step-counting pedometer to accumulate incidental physical activity on a daily basis. These steps can be measured over an entire day or at one or more specific instances. The beauty of the project is that almost anyone can take part without having to commit to strict fitness regimes. While 10 000 steps is the recommended daily minimum amount, individuals can easily perform more or less depending on age and general fitness levels, all the while accumulating their steps and improving their health.

Supported by evidence that physical inactivity in the population was contributing to the growth and social burden of some chronic diseases, such as cardiovascular disease, diabetes, obesity, some cancers and mental health, the initial two-year 10,000 Steps project was funded by Queensland Health in 2001. The project was a collaboration between CQUniversity Australia, University of Queensland, Queensland University of Technology and other partners including Rockhampton City Council and the National Heart Foundation. It became the first physical activity project to demonstrate the effectiveness of a community-wide approach to promoting physical activity, from the individual level through to environmental and policy levels.

The early project was effective in increasing physical activity, setting an example on how to conduct community-based health promotion programs elsewhere. Due to its popularity and success — 10 towns across Australia now identify themselves as 10,000 Steps towns — Queensland Health has continued to invest in 10,000 Steps to ensure its widespread adoption and implementation. This meant that the project had to be reinvented and

incorporate a significant service to community component. Both were done successfully and today the project continues to maintain an important research and information dissemination focus.

A key research theme of the project is to examine ways to improve the effectiveness of technology to promote physical activity through the use of technology-based promotion, such as websites and mobile devices. The 10,000 Steps program has a smartphone application (the iSteplog) that has been downloaded more than 36 000 times. This research theme has allowed the project to be leveraged as part of a $913 371 National Health and Medical Research Council Project Grant, which aims to better understand how to use technology to promote health. Outcomes of this project are expected in late 2015.

Since 2005, awareness of the 10,000 Steps program has been measured annually at a state-wide level. The general public's awareness of the project has grown every year and is now approximately 70 percent. This is higher than most other health promotion projects in Australia and internationally.

While dose-response relationships between physical activity levels and health outcomes are well established, there is an ongoing need for health behaviour research that demonstrates physical activity programs aimed at large groups of inactive people are effective in increasing, and maintaining, physical activity levels. That is why the ongoing research conducted under the banner of the 10,000 Steps project has been, and continues to be, essential.

Central Queensland University — Mask-ED™ and Pup-Ed

Chief Investigator: Professor Kerry Reid-Searl

Just imagine being able to create a safe, realistic and stimulating clinical learning environment without having to leave the classroom or working environment. That's exactly what the unique and innovative Mask-Ed™ (KRS Simulation) and Pup-Ed (KRS Simulation) techniques offer.

Mask-Ed™ stands for masking the human educator and the education process, while the acronym KRS represents knowledgeable, realistic and spontaneous simulation. An extension of Mask-Ed, Pup-Ed (puppet educator), uses puppets in a similar fashion.

Both Mask-Ed™ (KRS Simulation), which was first created in 2008, and Pup-Ed (KRS Simulation) offer unique and innovative approaches to teaching and learning.

Both techniques were created at CQUniversity by Professor Kerry Reid-Searl and are now gaining national and international recognition for their value in learning and teaching.

Mask-Ed™ involves the informed educator or teacher wearing silicone props including face masks, hands, feet and body torsos. Wearing these props, the educator transforms into a character or person (the patient) in the context of learning for health care professions. The newly created character also has a carefully created history that enables them to become the platform for teaching. In essence the teacher is hidden but still guides the teaching through the character, and the character becomes the coach for the learner in the simulation experience. The character and the history become a platform for teaching and serve as the learning tool for the educator, who draws on their expertise to guide the learning.

The key concept of Mask-Ed™ is that the simulation device takes training to a new dimension because the work is done on a real person, who is also the educator. Simulation learning facilitates critical thinking, reduces the risk element to actual patients and enables the educator to provide real-time feedback to their students. The technique is guided by a teaching framework and workshop materials including user guides and workshop manuals that have now been developed. Online resources are also being prepared for delivery in 2015. Local, national and international workshops are delivered regularly, with participants from across all health disciplines. Mask-Ed™ (KRS Simulation) has been trademarked and patents exist on some of the silicone props.

Pup-Ed works in similar ways but uses puppets. The informed educator works the puppet and transforms it into a character, creating its own history and platform for teaching. More than 50 puppets are currently being used in hospitals and educational institutions across Australia.

The effectiveness of Mask-Ed™ is evident in the number of universities, health care facilities and other organisations that have taken up the approach. The number now exceeds 20 sites throughout Australia, the United States of America, the United Kingdom and New Zealand.

Organisations taking up Mask-Ed™ are in the areas of nursing, physiotherapy, occupational health and safety, paramedics, psychology, speech therapy and medicine.

The growing success of these techniques are further evident in the extensive teaching awards, invited key note addresses and research findings that confirm the positive impact on learners and users. The overwhelming positive evaluations are supported by the extensive awards Professor Kerry Reid-Searl and Mask-Ed™ have received.

Mask-Ed™ has also benefited CQUniversity and the wider community by being used widely in community engagement presentations, school visits, Open Days and presentations to groups such as Probus, Rotary and University of the Third Age.

Certainly, based on the evidence to date, both Mask-Ed™ and Pup-Ed have the potential for continued growth not only in the research, teaching and learning arenas but also in their commercialisation.

Central Queensland University — Near Infrared Spectroscopy in Fruit Quality Assessment

Chief Investigator: Professor Kerry Walsh

A century ago, harvested fruit were graded by human visual inspection and sorted on their perceived quality. A new approach discovered a couple of decades ago from local fruit growers has resulted in the development of technology with worldwide application in the more accurate grading of fruit quality. Non-invasive devices using near infrared spectroscopy (NIRS) have been successfully developed in collaboration with various manufacturers and funding sources to improve the overall quality of fruit. Research undertaken at CQUniversity Australia has translated the theoretical potential of NIRS to commercial practice and explored related agronomic issues relevant to the production of quality fruit.

The NIRS project began in the mid-1990s following an approach from growers in the local Central Queensland pineapple industry who believed they were producing sweeter fruit than their southern counterparts and needed an objective test to demonstrate this. After exploring some colorimetric options, reports on the potential for NIRS were encountered, appropriate laboratory instrumentation was acquired and the concept was demonstrated to the fruit industry.

However, no appropriate equipment existed for fruit grading, with emergent Japanese technology too expensive and slow for use in western horticulture. An Australian Research Council (ARC) Large and ARC Collaborative grant allowed exploration of appropriate optical geometries (patent taken), instrumentation and chemometric development to allow practical use on packlines. Horticulture Australia Limited (HAL) funding further supported extension of the work into different fruit commodities and development of portable instrumentation that allowed in-field use.

From the late 1990s, the project team from CQUniversity worked with an Australian fruit grading manufacturer, Colour Vision Systems (CVS), to investigate how to integrate NIRS into a fruit packline. While continuing this collaboration the research team worked with a manufacturer of handheld devices, first Integrated Spectronics Pty Ltd, then, more recently, Felix Instruments Incorporated to produce a handheld NIRS device for use in assessment of fruit on trees.

The worldwide market for such devices is modest, such that the value of the technology is in the value added to fruit production, rather than equipment sales.

To support the uptake of the technology, the research team has worked with growers and supply chain groups focussed on production of quality fruit to use the technology to improve their product. For example, the technology has become integral to the success of the Calypso mango.

The project has not been without its challenges. An early business model collapsed due to the failure of Australian supply chains to provide reward for sweeter fruit and to changes

within the world's largest fruit grading manufacturer. Research has continued with a focus on identification of fruit with defects, i.e. negative features rather than positive features such as sweetness. Pilot commercial installations now exist in several apple pack houses, where sorting for internal browning occurs. Fruit industry groups like Montague also seek commercial advantage with retailers through use of internal defect sorting.

Management of harvest time decisions and ultimate eating quality are related to internal parameters including carbohydrate (sugar) content and defects such as flesh browning. Commercially, learning how to grow sweeter, as opposed to more, fruit has become significant. Interest in sweetness sorting has re-emerged within the citrus industry, which has a growing export market in Japan and Korea – markets that require and reward sweetness.

CQUniversity has been instrumental in these developments, working in concert with the engineers of CVS, and later French-based MAF Pty Ltd, for inline sorting technology, as well as those of Integrated Spectronics, then Felix Instruments Incorporated, for the handheld unit. The research group has also worked with various agronomic collaborators to develop protocols for the use of the technology within the production system, ultimately creating value in apple, citrus and mango supply chains.

The research that began in the mid-1990s with a local enquiry and in a modest confirmation of the work of Japanese researchers that NIRS could be used to sort high moisture, non-homogenous products such as fruit, has continued and now has global implications. Other non-invasive technologies do exist, e.g. transmission X-ray imaging, magnetic resonance imaging, acoustic frequency methods, although the widespread commercial adoption in fruit sorting is yet to occur using such technologies.

Central Queensland University — Reducing Downtime for Descaling and Cleaning Operations in Bayer Plants

Chief Investigator: Professor Masud Khan

It is surely a positive when money invested in research results in substantial cost-saving benefits for major industries. That is certainly the case with a recent project funded by Queensland Alumina Limited (QAL) that investigated ways to reduce downtime in its descaling and cleaning operations. Reduced flow efficiency due to scale growth and downtime of equipment can cost about a third of the refining process, hence the significance of finding a solution to the problem.

Scale growth in alumina refineries is a common phenomenon and occurs where supersaturated solutions used in the refining process, known as Bayer liquor, are in contact with solid surfaces. The simultaneous dissolution of impurities such as silica during the bauxite digestion process results in scale formation in many parts of process plants. Scale growth is a serious problem as it causes decreased efficiency of fluid flow systems over time, such as increased drag and blockages, ultimately creating excessive pump wear.

Stemming from the observation that, contrary to conventional wisdom, the rate of scale growth is more in fittings called reducers than in a straight section of pipe, a collaboration was formed between CQUniversity Australia and the Commonwealth Scientific and Industrial Research Organisation (CSIRO). It was with this collaboration that the project came into being. A reducer has a higher velocity that creates higher turbulence and therefore scale growth is expected to be less than in a straight section of pipe. The project was initiated to examine this occurrence and the effect of fluid flow characteristics, for example; flow velocity and turbulence, on scale formation.

The project undertook an experimental study at QAL's plant in Gladstone, Queensland, and results showed that the scale growth in Bayer liquor is strongly affected by fluid velocity while also influenced by a number of other factors. As observed in Nawrath et al. (2006), it was concluded that the scale growth rate decreases with increasing fluid velocity. The results suggested that the creation of flow instability within the boundary layer of Bayer liquor flow could be used to inhibit or suppress scale growth in the process equipment of Bayer plants (alumina refineries). It was also suggested that an increased flow disturbance or instability in the boundary layer could be used to enhance the effect of scale inhibition. Production of this instability helped achieve a large-scale suppression effect instead of using high velocity, which is difficult to produce due to operational limitations.

The results and outcomes of this research project provided solid evidence of the effect of fluid velocity. Most of the previous research and studies on scale growth concentrated on the nucleation and bonding phenomenon with little or no work on the role of fluid flow on scaling. It is for this reason that this project is significant and noteworthy — it has provided new results and validated the significant role of fluid velocity in scaling.

The project's findings have greatly influenced others to conduct further research to determine the relationship between fluid dynamics and scale formation mechanisms. The

outcomes and results have led to a new novel agitator design, Swirl Flow Technology (SFT), which was introduced as an alternative design to the widely used conventional draft tube agitator system to mitigate scale growth.

It is known that QAL has adopted the new SFT design and progressively installed this system, resulting in a reduction in scale growth. This has reduced downtime by about 50 percent, saving a significant amount of money, as well as increasing productivity and returns. While not reported in the public domain, the actual figure of savings is estimated to be large, directly benefitting the industry and, arguably, the state's economy.

Central Queensland University — Operational Readiness of Rural Firefighters

Chief Investigator: Professor Sally Ferguson

There are arguably few communities across the globe unaware of the devastating effects of bushfire. Concerns exist that the severity and frequency of bushfire is on the rise and with hotter weather and more intense fires requiring longer shifts and more frequent deployments there are significant threats to the operational readiness of the volunteers and salaried staff of Australasia's fire and emergency services. Safeguarding workers' operational readiness relies, in part, on a robust and relevant evidence base from which to build policies and procedures.

In the past, industry-specific research has been required to assist the fi re industry in developing comprehensive policy, best practice guidelines and training and educational materials in order to preserve the health and safety of their firefighters during multi-day bushfire suppression deployments. It was this exact focus that became the main aim of the Operational Readiness project.

Research was conducted jointly by the Appleton Institute and the Centre for Physical Activity and Nutrition at Deakin University. It was funded by the Bushfire Cooperative Research Centre (CRC) in collaboration with the Country Fire Service in South Australia, the Country Fire Authority in Victoria, the Tasmanian Fire Service, the Australian Capital Territory (ACT) Rural Fire Service, NSW Rural Fire Service and ACT Parks and Recreation. Following final sign-off by partners the data collection for the project began in 2012 and was completed in 2013, with the final report delivered in 2014.

A four-day bushfire suppression simulation tour was developed and validated with agency collaborators over a 12 month period in 2011. This provided the opportunity to study the impact of, and interaction between, multiple fireground stressors, i.e. sleep disruption and heat, on firefighters' physiological responses, as well as physical and cognitive work performance across a simulated four-day bushfire suppression tour. Findings were presented to key fire industry stakeholders to inform the development of comprehensive policy, best practice guidelines and training and educational materials for the preservation of firefighters' health and safety. These outcomes are now used by more than five fire and emergency services agencies and are an important aid for keeping our firefighters safe so that they can continue to keep us safe.

Prior to undertaking this project, research on the impact of multiple occupational stressors on firefighter performance and health was limited. For example, studies did not use tasks that resembled work on the fireground, the duration of the testing was much shorter than commonly experienced by our rural firefighters – hours compared with several days – and cognitive function was often measured in the absence of physical activity, in contrast to operational activities involving both functions. Further, observational studies in the field made it difficult to know what factors were actually having an effect. The emergency services sector sought information about the actual impacts on physical, cognitive and

physiological function under realistic, and controlled, conditions that simulated a strike team on deployment.

The research has proven effective with the incorporation of findings being developed into safe working guidelines at the sector level, as well as agency-level policies and procedures pertaining to health and safety of rural firefighters. The sector-level guidelines have been developed by the Australasian Fire and Emergency Service Authorities Council (AFAC), which is the peak body for fi re, land management and emergency services in Australasia, along with 32 member agencies and 13 affiliate agencies. AFAC guidelines are now used by agencies throughout Australasia as best practice, grounded in industry-led research.

This significant research project was driven by the industry need for evidence on impacts of exposure to multiple occupational stressors simultaneously on firefighter health and performance markers. Previous research was largely piecemeal, addressing only one element of physical performance or cognitive function or physiology, rather than taking a holistic perspective of the firefighter's performance. Today, the research team continues to be heavily involved with the emergency services sector to ensure ongoing improvements and updates to relevant best-practice guidelines, policies and procedures.

Central Queensland University — Distributed Power Tracking for Solar Systems

Chief Investigator: Professor Peter Wolfs

Is there a way to improve the yield of solar power systems on buildings that are often subject to shadowing from the building itself or adjacent buildings or trees? Researchers at CQUniversity have successfully patented a distributed maximum power tracking technology that greatly increases the yield of solar arrays subject to shadowing.

The initial underpinning research studied the problem of maximum power tracking at the solar cell level. Solar cells are assembled into modules that contain typically 30 to 100 cells. These modules are then assembled into arrays that may have tens or hundreds of modules. Maximum power tracking at the cell level represents the extreme boundary of distributed maximum power point tracking (MPPT) technology.

Maximum power tracking technology works to improve the energy yield. Even in favourable installation conditions arrays can experience 10 to 20 percent increases. In very poor conditions yields can increase by 50 percent or more. The effect is so profound that buildings where solar installations were previously unviable because of shadowing are now viable with this new technology.

It was while managing CQUniversity's solar car team that Professor Peter Wolfs first identified the opportunity to develop and distribute MPPT technology. Distributed power tracking imparts a benefit on a curved solar array — as found on solar cars; such cars also use arrays that are hand-built from single cells. In this instance the maximum power tracking was even more extreme with a MPPT being applied to the single cells. In this extreme case, where the distribution of many MPPTs were required, there needed to be a focus on methods that resulted in very low MPPT distribution costs and high energy conversion efficiency.

In order to examine the possible benefits of extending the range of electric vehicles, subsequent funding was provided by the Queensland Government from 2004 to 2006. This work resulted in Australian and the United States of America patents, with the Australian patent publication date being 12 July 2005. This significant piece of work appeared in key international conferences from 2005 to 2007.

After becoming aware of the technology, Tigo Energy, a privately held Silicon Valley company with venture capital inputs from matrix partners, OVP venture partners and Generation Investment management, was established in 2007 to develop MPPT products for building integrated Photovoltaic (PV) arrays. The technology that was developed used a distributed maximum power tracking system, based on a technical approach that had been patented by Professor Wolfs. As a distributed MPPT solution, the features of low cost and high efficiency that were pioneered during Professor Wolfs' solar car project became essential.

Tigo Energy subsequently purchased the rights to the CQUniversity patents in 2010. Today, the Australian and United States of America patents continue to be the central core of their distributed MPPT technology. For instance, the technology has been adopted by Tigo to produce their flagship product, the smart module, which allows module-by-module-based maximum power tracking within building-integrated and rooftop solar arrays.

In 2010 independent testing by Photon Laboratory GmbH showed the Tigo distributed tracking system increased the yield in a range of shadowing situations by 20 to 36 percent. Even for unshadowed arrays, which are considered to have very little loss due to mismatches, a three percent yield could be achieved. These results have enabled Tigo Energy to substantiate and demonstrate clear advantages in energy production.

The research, that forms the basis of the technology still being used today, revealed that highly economic MPPT structures could be developed using capacitive storage and switching power devices. In the conventional approach inductors are included to produce a continuous output current, however the work at CQUniversity between 2004 and 2006 proved this was not strictly necessary. The Tigo Energy Smart module regulators that were subsequently developed from 2007 onwards continue to exploit and leverage this significant innovation.

Central Queensland University — The Economic of Improving Water Quality into the Great Barrier Reef

Chief Investigator: Professor John Rolfe

Prior to this project being conducted, little economic analysis was available to review or guide policy and investment decisions dealing with the declining health of the Great Barrier Reef. Substantial scientific investments were made in relation to monitoring and understanding the ecology of the Great Barrier Reef, as well as the water quality draining from adjacent catchments. Evidence of continuing decline in the health of the reef led to calls for additional protection measures to be undertaken.

Led by the School of Business and Law's Professor John Rolfe at CQUniversity Australia, this particular program of research used cost-benefit analysis to evaluate the benefits and costs of additional investments in protection for the Great Barrier Reef. Ultimately this would enable more cost effective proposals to be prioritised and available public funding to be used to maximise environmental protection. Within this overarching goal, the economic research project has addressed concerns in four key ways.

First, it has demonstrated that there is a strong economic case for further protection of the Great Barrier Reef, particularly when comparing the community willingness to pay for additional protection against the potential costs of achieving this. This is the first time that this type of analysis has been provided. While demonstrating that the case for public funding is not open-ended, this work has been used within government agencies to help justify the continuation of funding for the Reef Rescue program, with a further $200 million committed by the Australian Government in 2013.

Second, the program of economic research has demonstrated that the costs to landholders of making management changes can vary greatly, both across and within enterprises. The analysis shows why it is not cost effective to achieve universal practice change and why generic programs that treat landholders and enterprises as homogenous units are far too simplistic. For example, it can be profitable for some enterprises to reduce fertiliser inputs or stocking rates but only to a certain level and in combination with other management changes. In addition, the research has identified why the costs of making changes vary with different enterprise, natural resource and climate characteristics, providing a guide to where lower cost management changes can be achieved.

The results of this type of analysis have provided government agencies and the natural resource management groups with better understanding about both the potential and limitations to management change. This has been one of the contributing factors that has resulted in an increased focus on adoption rates of better management practices, as demonstrated in the Great Barrier Reef report cards.

Third, the work with individual agricultural producers has identified reasons why some management changes and government initiatives may be more attractive than others. Many management changes have low or negative benefits to producers. In these cases change

may only be attractive through the payment of financial incentives. Even when change may offer financial benefits to producers, gaps in information, high transaction costs, risky outcomes or the complexity of making changes are all key reasons why landholders may be slow to adopt some practices. Results have shown that the cost effectiveness of public funding can be more than doubled when there is better understanding of economic trade-offs and prioritisation of project selection. This analysis provided policy makers and natural resource management groups with insights into how engagement initiatives and incentive programs can be better designed to improve the effectiveness of public funding.

Fourth, the work with natural resource management groups and government agencies on project cost effectiveness and project selection has demonstrated the large efficiencies to be gained from better targeting of project funds and more effective selection methods. The School of Business and Law research team has worked with several agencies and groups to trial different water quality auctions, assessment metrics and evaluation criteria including the Fitzroy Basin Association, reef catchments, Burnett Mary Regional Group, Burdekin Dry Tropics, Growcomm, CSIRO and the Queensland Department of Agriculture, Food and Fisheries. Almost all research activities have involved different partners and field experiments with landholders and communities. This has helped to improve understanding and prioritisation of project selection and funding initiatives.

In short, knowledge gained through assessing the costs of making changes in land management practices across different agricultural sectors and catchments has helped government agencies and catchment groups to better allocate funds. This project has identified the large variations in costs that exist, mapped the dynamic relationships between the profitability of enterprise and pollutant reductions, identified the factors that influence landholder take-up of better management practices and identified the most cost-effective priorities for investment in changing management practices. Significantly, this economic research project has provided policy makers and natural resource management groups with better information about strategic priorities and has fostered the adoption of more competitive selection processes focused on project outputs.

Central Queensland University — Don't FAID Away: a biomathematical model of human fatigue as a risk management tool in industries that employ shift workers

Chief Investigator: Professor Drew Dawson

Technological innovations, changes in customer demands and community expectations, and the emergence of global competition now requires many industries to operate 24 hours a day, seven days a week. In many developed countries, fatigue is recognised in occupational, health and safety (OHS) legislation as an identifiable workplace hazard that must be managed to minimise the risk to employees.

A key component of any hazard management system is the ability to both identify and assess hazards. This presents organisations that employ shiftworkers with a substantial challenge as it is difficult to quantify, and therefore manage, the fatigue risk associated with systems of work. Researchers at CQUniversity Australia's Appleton Institute have responded to this challenge by developing a biomathematical model to quantify the impact of shiftwork schedules on employees' levels of sleepiness, alertness and performance. Research conducted over the last 15 years in laboratory, simulator and field-based settings related to the impact of various sleep/wake and work/rest schedules on human fatigue levels has resulted in the development of various algorithms to estimate the level of fatigue associated with non-standard (shiftwork) duty schedules. This research has been conducted by Professor Drew Dawson, Associate Professor Greg Roach and Dr David Darwent.

InterDynamics is a South Australian software development company that has successfully incorporated these algorithms into a commercialised stand-alone software application called the Fatigue Audit InterDyne (FAID). FAID has been used by companies based in Australia and overseas.

Historically, fatigue risk has been managed by enforcing prescriptive rules that specify maximum duty limits and minimum rest limits. Duty schedules that comply with the rules are allowed as they are assumed to have low fatigue risk, while schedules that do not comply are assumed to have high fatigue risk and are thus disallowed. Such rules have been somewhat effective but they are inflexible and can produce perverse outcomes as they do not account for time of day effects. In contrast, FAID estimates the fatigue levels associated with a schedule based on the length of its duty periods and rest periods, as well as the time of day that they occur. Rather than determining whether a schedule is allowable or not, FAID categorises the fatigue level associated with each duty period as being low, moderate, high or extreme. This information can then be used to minimise and/or mitigate fatigue risk.

FAID forms part of an overall fatigue risk management system that enables users to reduce the occurrence of fatigue-related incidents, accidents and fatalities.

Under OHS legislation organisations that employ shiftworkers have a duty of care to minimise the likelihood that their employees will be adversely exposed to fatigue. Many organisations have developed fatigue risk management strategies based on the principles of safety management systems. The basis of traditional fatigue management systems has been to minimise the risk to employees by providing multiple, redundant layers of defence against potential fatigue hazards. Dozens of organisations, such as Union Pacific and easyJet, have incorporated FAID as a layer of defence in their fatigue risk management systems and use it to assess and manage the fatigue risk associated with planned and actual duty schedules.

FAID has produced two measurable economic and safety benefits of significance:

- **Economic**

Since 2001, InterDynamics has received $5 million in revenue from the sales of FAID. FAID licences are currently held by 350 organisations in Australia and overseas. Professor Drew Dawson originally licenced the biomathematical algorithms to InterDynamics in 1999. Since then, InterDynamics has renewed its licence in 2003, 2007 and 2013.

- **Safety**

Union Pacific Railway has used FAID to aid the design of fatigue-friendly rosters since 2001. Since then, the incidence of planned rosters with fatigue exceedances has been reduced by 20 to 30 percent. Prior to the introduction of FAID, Union Pacific Railway averaged five fatigue-related fatalities per year. In the 10 years that the organisation has been using FAID, it has not had a single fatigue-related fatality. It is likely that the development of fatigue-friendly rosters using FAID has contributed, at least in part, to this reduction in fatalities.

Central Queensland University — The Impact of Electronic Gambling Machine Jackpots on Gambling Behaviour

Chief Investigator: Professor Matthew Rockloff

Many people enjoy a flutter every now and again. Nonetheless, it is well established that gambling can cause financial, psychological and health-related harms to gamblers, their families and the community due to excessive use and expenditure. In Australia, annual social costs of gambling are estimated to range between $4.7 and $8.4 billion. Of all forms of gambling, poker machines or electronic gambling machines (EGMs) are consistently found to present the most significant risk to individuals, with elevated use of EGMs most strongly associated with the development of gambling problems.

Jackpots enhance the appeal of electronic gambling by giving gamblers the impression that they can achieve an immediate reversal of their losses by virtue of winning the jackpot. Given the ubiquity of this feature of EGMs, knowledge of the potential impact on gamblers in terms of promoting unsafe gambling behaviour is critical. Motivated by a lack of research both in Australia and overseas on the impact of EGM jackpots on player behaviour, Gambling Research Australia, Australia's main gambling research funding body, commissioned a report by the Experimental Gambling Research Laboratory (EGRL) at CQUniversity in an attempt to answer a number of questions. Such questions included do jackpots and linked jackpots increase the likelihood of risky gambling behaviour and gambling-related harm, and to what extent do jackpots enhance the player experience?

The EGRL undertook its multistage $250 000 project involving experimental, survey and in-venue player monitoring methodologies from November 2011 to December 2013. The resulting report provided the first major body of empirical evidence on the impact of EGM jackpots on player behaviour. State and territory governments are now using the report to evaluate jackpot payout mechanisms and sizes, with the ultimate goal of determining the safest products for consumers.

The research also explored a novel player protection measure, jackpot expiry, which was devised to address the most evident risk associated with jackpots: this risk being, the potential to increase the persistence of players who are losing in the hopes of achieving an instantaneous reversal of fortunes. Jackpot expiry is a player protection measure whereby the availability of jackpot wins expires after a fixed interval of play. Jackpots that expire have a lock-out period and player-identification technology, such as smart cards will prevent players from switching machines to revive potential jackpots. It allows people to consider whether they want to continue gambling. They can continue, if they wish, for pure recreation and to enjoy small wins but they are locked out of winning the jackpot prize.

This research found that participants who receive a relevant message regarding jackpot expiry significantly reduced their betting and cashed out of the EGM with more money remaining than those in the control conditions. EGM jackpots were associated with greater

spend overall and those more at risk of developing gambling problems tended to be more vulnerable to the influence of jackpot features, leading to greater persistence in the face of losses.

Progress was also made in terms of advancing the theory of why jackpots tended to result in more intense gambling, as participants primed with aspirational imagery tended to gamble more. These outcomes have a direct influence on how statutory authorities should most effectively manage allowable features of EGMs placed in venues in the Australian community. The report suggests that large jackpot prizes are differentially attractive to players with problems and provides some evidence to suggest that players can be better protected by placing limits on the awards of jackpots.

In summary, the impact of the research in providing knowledge of the elevated risks caused by jackpot-enabled EGMs is informing policy makers and regulators in determining the constraints enforced on EGM features in casinos, pubs and clubs. Regulators in Australian states and territories are currently reviewing the structure of EGM payout mechanisms, as well as jackpot sizes, to determine the safest configurations for Australian consumers.

Central Queensland University — Smart Brakes

Chief investigator: Professor Colin Cole

Since the time of Edison, the worlds of commerce and research have generally enjoyed a positive and mutually beneficial relationship. At the time that Edison began swamping the world with more patents than actual inventions being taken to the market, a key lesson was learnt – a challenge to a patent submission can often be an indicator that someone has come up with a good idea. In a similar manner, although now resolved, such was the case with a challenge to the development of an electronic smart brake system for freight trains developed in a research partnership between CQUniversity Australia, Faiveley Transport Pty Ltd and the Queensland Government.

Originating in earlier work at the Centre for Rail Engineering and the Cooperative Research Centre (CRC) for Railway Engineering and Technologies this research was designed to develop electronically controlled train brakes and associated smart devices for freight trains. Freight trains still have the same basic operating principles of air braking that was derived in the late 19th century. Given that the control medium is air pressure, the control signal cannot move along the train any faster than sonic velocity. This leads to the familiar 'clunk-clunk-clunk' sound we hear in trains.

While electronic braking has been available in passenger trains for some time, there are difficulties in freight trains due to the train length and the fact that freight wagons have no electric power. The need for electronic brakes has continued to increase as heavy haul trains have become longer. Trains of 2.4 kilometres are common in Australia, with longer trains of up to 4 kilometres currently operating in South Africa and proposed for new projects in Australia.

Freight train electronic braking products started to emerge in the mid-1990s, however uptake was very slow. The principal reason for the slow uptake was the fleet roll-out cost and the massive job of fleet-wide retro-fits. In contrast to the slow uptake, the benefits of electronic brakes can be readily seen in uniform brake application — as signals traverse almost instantaneously — giving significant improvement in train stability and safety during braking. In addition, energy can be saved as braking is more precisely controlled.

The roll-out of electronic brakes also offers a new era in freight train safety and early warning systems. The addition of an electronic brake system adds both electrical power and communication to each wagon. This opportunity means that for the first time each wagon can be monitored for faults or derailment. While this technology might not prevent catastrophic and instantaneous derailments, which often have many different causes, it does allow monitoring of degrading track or wagon conditions. Ultimately this enables remedial action before failure. This type of technology can prevent partial derailment such as a dragging wheel, which has been known to travel up to 20 kilometres, destroying most track sleepers in the section before the train finally derails catastrophically.

The impact and effectiveness of the research can be summed up in its two successes. Firstly, the development of an electronic braking product that can be retrofitted to a large

percentage of freight rail fleets in Australia, Europe and the United Kingdom. Secondly, the development of a train health advisory system product that is integrated into the electronic braking product, which again is easily fitted to freight rolling stock and provides the capability of every wagon condition monitoring.

The underlying research enabling these impacts was the development of a robust low power brake control product for operation in the severe on-wagon environment, as well as robust and low-cost condition monitoring technology for each wagon that required a minimum number of transducers. This innovation required development of inverse modelling techniques to achieve useful reporting from simple and robust transducer installations.

The design was modular, configurable and cost effective and required no maintenance. Despite early attempts to derail the commercial end of this worthy project, the research still remains significant and relevant. Today, cost-effective electronic smart brakes for freight trains are very much a reality.

Charles Darwin University — Finding Solutions to Support the Energy and Resource Sector in Northern Australia

Primary Partners or end-users: Charles Darwin University (CDU); Northern Territory (NT) Government; Ichthys LNG Pty Ltd: a Joint venture between INPEX group companies (the Operator), major partner Total, CPC Corporation Taiwan, and the Australian subsidiaries of Tokyo Gas, Osaka Gas, Kansai Electric Power, Chubu Electric Power and Toho Gas; Energy and Resource Sector operating in Northern Australia.

Sector: Government; private industry.

Sources of Support: In 2012, the Ichthys LNG Project Joint Venture participants committed AUD3 million to the construction of the AUD 5.24 million North Australian Centre for Oil & Gas (NACOG) facility based at the CDU campus in Darwin, NT. The NT Government also contributed to the cost of the facility with CDU providing the land.

Purpose of programme

- NACOG undertakes research to support the resource and energy sector in Australia's north.
- For example, NACOG has a particular focus on corrosion-related issues relevant to the oil and gas industry that are unique to tropical environments.
- Corrosion is an issue for any industry, but especially for petroleum production and processing operations located off-shore or near the coast. Northern Australia's extreme wet tropical climate makes for a particularly challenging environment.
- Darwin is, therefore, an ideal location to investigate corrosion prevention and control in the wet tropics, with the aim of helping industry reduce its maintenance costs and extend the effective life of plant and equipment.
- Many corrosion issues can be prevented or mitigated through appropriate design, monitoring and control systems.
- The overarching purpose of CDU's Corrosion Research Program is to determine how the marine environment in tropical waters affects equipment, and then assist with improving the integrity of the materials so they are better suited to northern conditions.

Summary of collaborative approach

- In collaboration with Industry and government, CDU established NACOG.
- The purpose of this investment was to develop the training and research capability in the Northern Territory to respond to, and support the growth opportunities in the resource and energy sector.
- This focus and investment aligns with the priorities outlined in the White Paper on Developing Northern Territory, and the emphasis on meeting the energy needs of

Australia's region. LNG, in particular, has rapidly become an important export for Australia and is now Australia's third largest export after iron ore and coal.

- As outlined above, NACOG represents a partnership between industry, CDU, and the NT Government. It was established in 2012. The Ichthys LNG Project Joint Venture participants committed AUD3 million to the construction of the NACOG facility based at the CDU campus in Darwin, Northern Territory. The Northern Territory Government also contributed to the cost of the facility with CDU providing the land

Details and analysis of impact

- A social return on investment (SROI) evaluation was undertaken on NACOG by INPEX to understand the value created by the investment. SROI uses established economic valuation techniques to express the social, environmental and economic impacts of a program or organisation in monetary terms.
- The value created by NACOG found that for every $1 invested $4.50 of social and economic value was created over the fifty-year life of the building.
- Investment in NACOG has attracted staff with particular expertise and enabled the university to develop a new capability in the NT to serve the needs of this growing and important industry.
- Following the oil and gas industry boom in Northern Territory, there has been a demand for upskilling in a number of areas including engineering. Two areas of engineering NACOG concentrates on are corrosion and materials engineering. Corrosion is a significant issue in the oil and gas industry due to the variety of chemicals used and, more so, in the tropical weather conditions of Northern Territory.
- In engineering which involves conception, design, implementation and maintenance, NACOG has been providing support to the industry in problems involving selection, repair, and maintenance advice and through failure analysis to inform the system engineering process.
- The close interaction with industry has resulted in industry having confidence in NACOG and drawing upon its expertise. This in turn has resulted in local industry development with local skills.
- A number of research students of CDU have undertaken thesis projects to develop skills in areas that are relevant to the local industry.
- The corrosion research facilities at NACOG include a Gamry 3000 potentiostat, Instron 250kN machine, impact testing machine, Fanuc Welding robot integrated with Lincoln STT welding machine and metallographic facilities. There is also a scanning electron microscope which helps in failure analysis.

Charles Sturt University — 'EverGraze' Project

End-users: Sheep and Beef farmers in High Rainfall zones in Southern Australia

Next Users: Private consultants, public sector advisers

Research Partners: Charles Sturt University (CSU), NSW Department of Primary Industries (NSW DPI), Department of Environment and Primary Industries Victoria (DEPI Victoria), Department of Agriculture and Food WA (DAFWA)

Sector: Private (farmers and private consultants), public sector (e.g. state departments)

Sources of Support: $33 million (cash and in-kind) between 2004-2014

Major cash supporters: Meat and Livestock Australia (MLA), Future Farm Industries CRC, Australian Wool Innovation (AWI), Caring for Our Country scheme (for some on-farm demonstrations)

Summary of collaborative approach

EverGraze was a national research, development and extension partnership. EverGraze was facilitated by the Future Farm Industries Cooperative Research Centre (FFI CRC). It delivered farming systems research, development and extension for the sheep and beef industries in the high rainfall zone of southern Australia. Its main premise was to undertake R&D to increase the profitability of livestock enterprises in the high-rainfall zones of southern Australia, while at the same achieving reductions in groundwater recharge (reducing salinity) and soil loss by water and wind. Initial activities included whole farm systems and catchment modelling to identify the types of systems (livestock enterprise, mix of perennial pasture types across the farm) likely to achieve the dual objectives of increasing farm profitability and reducing groundwater recharge, and the catchments in which the environmental benefits would be greatest. This led to a network of experimental sites being established across southern Australia in NSW, Victoria and Western Australia to test the new farm systems over a number of years. Modelling also identified knowledge gaps, that if addressed, could significantly increase farm profit and improve environmental outcome. This led to the establishment of other on-farm research projects to investigate these gaps. Importantly, all experimental work was designed and implemented in consultation with regional groups (Regional Advisory Groups) representing leading farmers (end-users) and consultants (next-users), to ensure the outcomes of the work would be of relevance to next and end-users. Following the completion of the research, data was used to further validate models to test the impact of adopting the new systems over a wider range of years. Research outcomes were then discussed and built into key messages in consultation with the regional groups. These key messages were developed to consider the whole-of-farm implications of adopting findings, as previous research had shown that farmers often do not adopt research recommendations because they are unsure of the implications adoption may have on other aspects of their farm system. The key messages developed were incorporated into regional packages, to ensure they were regionally relevant, and housed on the EverGraze website (www.evergraze.com.au).

Major participants in the project were partners in FFI CRC and its predecessor, the CRC for Plant-Based Management of Dryland Salinity (Salinity CRC), which commenced in 2001. Many of the key researchers in EverGraze had previously worked together on other national research programs such as the Sustainable Grazing Systems program, which concluded in 2001. Learnings from programs such as this informed the design of the EverGraze program.

Collaborative processes were underpinned by FFI CRC processes. Funding was managed by FFI CRC (or the predecessor Salinity CRC), who invoiced other funders (MLA and AWI) when milestones were achieved (MLA and AWI also reviewed milestone reports). Separate research nodes were established for each of the major research regions, and a site leader appointed for each, who was responsible for managing the local research team and activities, liaising with the Regional Advisory Group, and submitting milestone reports. The project implemented annual team meetings where representatives from each research node met to present research findings and discuss whole-of-project issues. A project leader was appointed from one of the partner organisations, and towards the end of the project devoted 0.8 FTE to the role.

In addition, there were four Higher Degree by Research (HDR) students trained at CSU as part of this project, and a fifth student enrolled through University of Melbourne.

Analysis of collaborative approach

Contributions of each party

CSU, NSW DPI, DEPI Victoria and DAFWA provided research, development and extension activities. All parties effectively engaged in research activities, although at some research sites industry outcomes were hampered by less effective consultation with the Regional Advisory Groups. The process of developing the research messages involved the partners in consultation with the Regional Advisory Groups. Extension activities were primarily undertaken by the partners, although some activities were undertaken by consultants. Development of key messages and extension activities were highly effective, as gauged by the level of next and end-user engagement in the project, and project impacts, as detailed later. Limited training of next users occurred, which involved various project partners, but was led by DEPI Victoria.

Specific steps to support/achieve mutual interests and benefits

Each partner agreed to their role in the initial project application for funding in 2004, and again when applications for refunding were made every three years. Annual team meetings and monthly teleconferences enabled partners to discuss progress at each node and the importance of appreciating different organisational drivers. For example, for CSU refereed publications are an important metric, however it was also viewed as important to undertake work of industry relevance, even though there was no direct financial benefit of this. For state departments, engaging with industry to undertake research that leads to more profitable and sustainable farms systems was viewed as critical, and while publication of results in peer-reviewed was a lower priority, the collaboration emphasised the important of having the evidence for the key messages, a process which drove publication outputs from these partners. Involvement of next and end-users in the Regional Advisory Groups

required the payment of small sitting fees, although the longevity of membership (with most groups remaining unchanged across the life of the project) is testament to the relevance of the work undertaken within the project.

The most successful element of the collaborative approach

The most successful element was involving next and end-users in setting research priorities and questions, throughout the research, and in the development of the key messages arising from the work. This ensured the outcomes and outputs (website key messages etc.) were of relevance to farming systems, and was a key reason why the impact of the project was so profound (see later). It also assisted in keeping the team focussed, even though they were working on different projects and had different institutional drivers. Being answerable to a group of industry experts reduced the risk of a regional team losing direction in their research, development and extension activities. FFI CRC management also played an important role in holding participants accountable to their commitment, and also managing the expectations of other funders such as MLA and AWI.

Lessons learnt for future/ongoing collaboration

- A formal agreement between partners, as existed in EverGraze when participants signed up to the CRC, is important to manage ongoing commitment to a long collaborative project.
- Involving next and end-users in framing the research questions is important in ensuring research has industry relevance. Supporting their regular input into the research, development and extension activities is important in maintaining focus of activities.
- Utilising the expertise of industry in interpreting what research outcomes mean for industry, particularly for complex systems such as farms, is critical to ensure the industry credibility and useability of key messages, to facilitate maximum adoption.
- For a complex industry like agriculture, undertaking RD&E on a within-industry (or discipline) basis can be problematic in generating relevant outcomes to drive productivity gains. EverGraze involved a wide variety of research expertise (animal nutrition, reproduction, soil science, agronomy, biophysical modelling) and had cross-industry support (MLA, AWI and others). This resonated with end-users who operate multiple enterprises and who need to deal with interdependencies between disciplines and enterprises in their farming systems.
- Do not over-estimate the capacity of next-users to think in a systems context. EverGraze needed to spend more time than anticipated training advisers to consider whole farm systems issues in order to deliver messages effectively – many advisers only had the capacity to think on a within industry/discipline basis.

Analysis of impact

Based on a 2014 analysis, an estimated 4400 producers made changes to their farm, impacting on more than 960,000 ha, as a result of what they learnt through EverGraze. This high rate of adoption is attributed to the integrated nature of RD&E in EverGraze. From its inception, EverGraze placed a high priority on the extension of its findings to next and end-

users in the high rainfall grazing zones of southern Australia. Between 2005-2011, extension focussed on raising awareness through field days at the research sites, targeted workshops, and piloting training programs, engaging 14,700 people (mostly farmers). Data was collected from those attending these events to ascertain whether they found the activities useful, and whether they intended to change any practices on farm as a result of what they had seen. Of these, more than 4000 subscribed to the EverGraze database, and received four newsletters annually. The EverGraze website also received an average of 1500 visits per month prior to 2011.

From 2011 onwards, while some research was ongoing, EverGraze focussed on delivery of outcomes to industry, which resulted in regional packages which presented research outcomes within the context of what they meant for farm systems in each region. This also led to the development of online tools for producers to use to decide whether adoption was right for their own farm system (for example see the pasture flushing tool). A series of training courses were developed to upskill advisers and farmers in making strategic decisions related to perennial pastures on farm. In total more than 570 information products and tools were loaded onto the revised website, which received over 12,000 unique visits between August 2013 and April 2014. A survey of the 4043 clients on the EverGraze database in 2014 revealed that the website and associated products were highly trusted and valued (8/10) across all audiences – producers, advisers, researchers and organisation managers.

A 2014 benefit-cost analysis (BCA) indicated the total return from changes to the farm practices as a result of EverGraze was $306 million to date, equating to a return on the $33 million project investment (cash and in-kind) of 9:1. Separate BCA analyses undertaken by MLA and AWI have indicated a similar BCA. Given the nature of adoption, it is expected benefits will continue to accrue. The EverGraze website, which hosts the regional packages, is now managed by AWI and is updated as more information becomes available, although as the website is not actively promoted now the project has ended, it is expected that interest in it will decline over time.

Many of the networks established within EverGraze remain, resulting in ongoing R&D projects in related areas. The EverGraze project was a finalist for the Sustainable Agriculture Category for the 2014 Eureka prizes, based on the innovative research undertaken and its industry impact.

Deakin University — Quickstep Collaboration

Partners: Quickstep Holdings.

Sector: Automotive manufacturing.

Sources of Support: Geelong Region Innovation, Commonwealth Investment Fund (GRIIF), Victorian Government, Deakin University, Quickstep Holdings.

Background and purpose

To create jobs and economic growth, Australian manufacturing requires transformation with a focus on design, innovation and smart solutions. As a strategic priority, Deakin University works actively with industry to foster manufacturing growth in the Geelong region and beyond.

Quickstep Holdings is Australia's largest independent manufacturer of carbon fibre composites, with sales of $39.5 million in the 2015 financial year, up from $12 million in 2014. With a focus on materials development, equipment and composites manufacturing, the company has partnerships with some of the world's largest aerospace and defence organisations, such as the US Department of Defence, Lockheed Martin, Northrop Grumman and Airbus.

Quickstep's headquarters are in Sydney, where it has an aerospace composites manufacturing plant, and its research and development facilities have, until recently, been in Germany, involving around 15 staff.

In addition to its aerospace activities, Quickstep is now expanding into the global automotive sector, with a focus on developing turnkey process solutions and services, producing prototype components and undertaking low volume manufacturing. The company's patented Quickstep Process for rapid curing of composite materials allows adaptable, high volume production, placing it in an ideal position to capitalise on the multi-billion dollar global automotive market.

To create a critical platform for this development, the company sought to establish a new Automotive Division within the carbon fibre composites precinct at Deakin's Geelong Waurn Ponds Campus. Here, it would be in close proximity to the world class researchers and facilities at Deakin's Carbon Nexus — a globally unique, open-access carbon fibre/composite research facility.

Quickstep secured a Commonwealth grant of up to $1.8 million under the Geelong Region Innovation and Investment Fund (GRIIF) to establish the division. Once suitable space within existing structures was identified, the arrangement offered Quickstep and Deakin the opportunity to develop critical research pathways, training programs and agreements that would accelerate growth, to the benefit of both parties.

Summary of collaborative approach

Nature of collaboration

Deakin and Quickstep sought to develop their collaboration in the following areas:

- research and development in carbon fibre and advanced composite manufacturing technologies
- provision of access by Quickstep to existing facilities at Deakin's Waurn Ponds Campus, to accommodate development of Quickstep's Automotive Division, including research, production and component manufacturing and accommodation of associated staff, equipment and services
- the placement of Deakin students in Quickstep operations for research, manufacturing experience and mentoring
- employment opportunities for Deakin students and graduates
- the potential participation of Quickstep staff in relevant courses offered at Deakin
- staff secondments and joint appointments
- commercialisation of new IP.

During the negotiation process, it was also agreed that Quickstep would relocate its research and development function from Germany to Waurn Ponds, with Deakin to be engaged as Quickstep's principal research provider. The Victorian Government allocated $310,000 to Quickstep to assist in this process.

Pre-existing relationship

The relationship between Deakin University and Quickstep dates back to early 2001. Deakin assisted Quickstep in the testing and development of the Quickstep Process, with two Quickstep machines located at Waurn Ponds, one of which is in use at Carbon Nexus. The two parties were also in a three-year partnership on an Australian Manufacturing CRC project, to validate the Quickstep Process, which involved 12 PhD graduates, one of whom now works for Quickstep in Bankstown. Quickstep has also recently supported a successful bid by Deakin for an Industrial Transformation Research Hub.

Mechanisms for implementation and management

A Memorandum of Understanding was established between the parties, which led to a Heads of Terms agreement that defined key research and lease parameters. A Research, Education and Employment agreement was then established to guide research, future education and employment opportunities, and a lease agreement was finalised to accommodate Quickstep's needs over the next three years.

A co-ordination committee involving senior personnel from each party has overseen the collaboration, with a project management group co-ordinating the building modifications.

Analysis of the collaborative approach

Deakin allocated space of 726 square metres in an existing building to meet Quickstep's initial manufacturing and production needs. Some building works were required to develop this space as a discrete area, upgrade services to the facility and create a new entry for Deakin's campus deliveries. A further 107 square metres of building space is currently being refurbished to accommodate additional Quickstep staff.

Deakin's contribution to the cost of works is approximately $200,000. Quickstep will contribute similar funding and will be fully responsible for its internal fit-out and operational costs. Under the agreement, Quickstep will contribute approximately $1.75 million over a three-year period for research projects at Deakin.

Details and analysis of impact

The Geelong region is ideally placed to lead manufacturing transformation, with its diverse industries, historical manufacturing strengths, extensive supply chains and connections to markets; combined with the research excellence and technology-oriented culture at Deakin University.

The Quickstep Automotive Division will focus on two lines of production: manufacturing equipment for manufacturers to produce automotive parts; and producing parts directly for use by automotive manufacturers. These activities will have a significant flow-on effect for local jobs and broader industry growth in the carbon fibre/composites area.

Co-location of Quickstep with Deakin is a vital step forward in building more effective collaboration between research and production, accelerating growth and enhancing education and employment opportunities for students.

Quickstep is making progress in securing initial contracts with automotive companies for the supply of composite parts and further research and development is now under way.

Benefits to Deakin

This collaboration will provide Deakin University with access to more research projects, income and outputs and involvement in potential development and commercialisation of new IP. It will also provide the Deakin community with access to further state-of-the-art production equipment for research and training purposes, through internships, employment, secondments and joint appointments.

The expansion of Deakin's carbon fibre precinct will also enhance the University's reputation for supporting industry development and add a new incentive to attract other commercial ventures.

Benefits to Quickstep

Access to the facilities at Deakin's Waurn Ponds Campus will accelerate research, development and commercialisation, providing an expanded knowledge base for product and process development. The co-location of Quickstep's dedicated research and

development centre with its Automotive Division will also support the development of new IP - bringing IP development and control back to Australia from Germany.

Participation in a growing industry precinct, in close proximity to major clients and with enhanced access to well-trained potential employees, will also have significant benefits for Quickstep. Association with Deakin - one of Australia's leading universities — will also provide Quickstep with stronger strategic support.

Benefits to Industry

This partnership will open up a number of employment opportunities for the Geelong region, including direct employment of over 30 staff within the first three years.

It has attracted two 'footloose' investments to Geelong that will provide enhanced supply chain opportunities for a range of Victorian suppliers. It is expected that benefits from this smart solution-driven partnership will flow on to many industries across the region.

Edith Cowan University — Industry Engagement Scholarships

Partners or end-users: Partners have included private industries and government departments.

Sector: Partners have included private industries and government departments.

Sources of Support: External funding and in-kind support through industry partners, and internal scholarship allocation and internal fee waivers.

Purpose of programme/project

What was the problem or issue being addressed? Was there a particular solution to be achieved?

In 2014, ECU established a range of industry engagement scholarships (value $100,000 over 3.5 years) with the purpose of growing both the number of PhD students and projects engaged with industry. In addition, ECU sought to enhance the professional development and career opportunities for doctoral candidates through this program. In total, three rounds have been held, attracting 29 proposals for industry projects. In total 14 industry engagement scholarships have been established.

Summary of collaborative approach

What was the nature of the partnership/collaboration?

ECU established a program whereby a portion of the scholarship budget for the university was devoted to industry engagement projects. ECU researchers were invited to submit an expression of interest for a project with an industry partner, community organisation or government agency. The industry partners selected complemented and built on ECU's research strengths. Industry partners were required to contribute significantly to the research direction and provide support, including cash and in-kind support appropriate to the project. Where external funding was provided, this was in the form of research funds to support the project, or as a top-up to the ECU scholarship (currently $27,000 pa).

Was there a pre-existing partnership? How long has it been in effect?

Within the 14 projects established, some were based on existing partnerships, others were new opportunities.

What were the mechanisms employed to implement and manage the collaborative processes?

ECU researchers managed the engagement process with the industry partner. The Graduate Research School managed the EOI process, and industry engagement partnership agreement.

Analysis of collaborative approach

What were the contributions of each party? Were they appropriate and effective?

The table below summarises the 14 projects and the level of contribution provided. Through a competitive process, these projects were selected, and the support provided by these industry partners was deemed appropriate. The effectiveness of the support will be assessed retrospectively on project completion.

Partner	Project	Funding
Department of Health, Western Australia	Putting the public back into public health: visual communication of public health data for public understanding	$9,000 research support $10,000 in-kind
Football West	The physical and mental health benefits of Football West Inclusive Programs in Western Australia	$15,000 research support $5,000 in-kind
Australian Institute of Sport	Preparing for Flight: Creating optimal states of readiness in combat sports	$17,500 research support $7,000 in-kind
WA Football Association	Female participation in AFL in WA: The associated health benefits for females	$15,000 research support $8,500 in-kind
Port Adelaide Football Club	Developing guidelines for the technical, tactical, physical, physiological and perceptual demands of Australia Rules Football players.	$15,000 research support $200,000 in-kind
South Australia Water	Assessing the capacity of seagrass sediments to sequester carbon dioxide and metal pollution: past, present and future scenarios.	$5,000 research support $34,650 in-kind
Department of Fire & Emergency Services	The influence of combustion conditions and vegetation type on the chemical composition and toxicity of smoke	$30,000 research support $30,000 in-kind

Partner	Project	Funding
South West Catchments Council	Identifying nutrient and organic matter sources in an impacted coastal wetland system	$48,000 research support $11,620 in-kind
Kormilda College	Developing outstanding cultural competency for beginning teachers working with Aboriginal and Torres Strait Islander students in secondary boarding schools in northern Australia.	$4,000 in-kind
Bayswater City Soccer Club	How perception of capabilities influence decision-making in football players of different age groups, and in-turn how they affect team patterns	$6,000 scholarship top-up $4,000 research support
Australian Institute of Sport	Influence of recovery strategies on adaptation to training and competition performance of Australia's elite athletes	$9,000 scholarship top-up $5,000 research support $3,000 in-kind
Bioyong Technologies	Glycan profiling as a risk stratification biomarker for metabolic syndrome	$1,000 scholarship top-up $10,000 research support $20,000 in-kind
Disability Services Commission	The design of a digital seating assessment to maintain best practice and good outcome for people with disabilities	$9,000 research support $30,000 in-kind

What specific steps or activities were taken to support/achieve mutual interests and benefits, due to the different organisational drivers?

Industry partners were actively engaged in the project development phase, and committed financially or in-kind to the project.

What was most successful element of the collaborative approach?

The opportunity for ECU to build collaborative links with industry, and offer students doctoral projects with additional funding, professional development, career opportunity, industry partnership and a focus on research impact.

What lessons were learnt for future/ongoing collaboration?

Internal change for the industry partner sometimes resulted in a change in focus/withdrawal from the program. In addition, projects were within defined areas, and did not always attract a high number of quality applicants. Hence the lessons learnt for future collaboration:

- Keep the negotiation and partner agreement timeframe short
- Establish a greater number of industry projects than scholarships on offer.

Details and analysis of impact

How well did the programme/project achieve its objectives?

The objectives of the program were to increase the number of PhD projects engaged with industry. This has been achieved, and to date 14 projects have been established through this process.

What has been the impact of the programme/project (social, economic, commercial, community and/or other impacts)?

The impact of the program from broader social, economic, commercial, community and/or other impacts has yet to be realised. These will become evident as students engaged in the program complete their degree.

How do or did you measure/evaluate the programme's impact? What was the time frame?

The timeframe for evaluation is 3 years (2018) from commencement of the industry engagement scholarship. Annual data will be produced summarising:

- Student progress
- Completion rates
- Citations
- Patents
- On-going or long-term collaboration arising from the project.

Is there likely to be on-going impact?

Yes, the ongoing impact of the program will likely be greater levels of:

- engagement with industry in research projects at ECU
- engagement between industry and ECU researchers

- research impact.

In addition, PhD candidates will be trained in a way that gives them upfront career options; either within research or in the broader economy, where they'll be viewed as valuable assets with high levels of skill and creativity.

Have there been any evaluations and/or follow up studies of the programme/project?

None to date.

Is there any specific data or other evidence of academic or other impact (e.g. citations, patents, start-ups, ongoing or long-term collaboration arising from the programme/ project)?

Not as yet.

How did the collaborative approach contribute to the impact?

Collaboration is inherent to the program, and only those projects with a significant level of industry engagement, and those with research impact were selected.

Edith Cowan University, Curtin University, Murdoch University, The University of Western Australia and University of Notre Dame Australia — iPREP WA

Partners or end-users: More than 10 companies have participated so far, including FMG, Exxon Mobil, CingleVue International, UXC Eclipse, SEMC, Lateral, Southern Cross Care, Advantage Air, Bombora Wave Power, Pilbara Ports Authority, Citic Pacific Mining and Department of Health. Program has also been supported by the Department of Premier and Cabinet (Office of Science), Department of Commerce and SpaceCubed.

Sector*:* Partners have included private industries and government departments.

Sources of Support: Each of the collaborating universities provides 50 per cent of the stipend for their participating students, with additional funding provided by the industry partner. Program costs and in-kind support provided by Department of Commerce, Department of Premier and Cabinet (Office of Science), and SpaceCubed.

Program overview

iPREP (Industry and PhD Research Engagement Program) is unique in that PhD candidates who have submitted their thesis for examination are given the opportunity to work in interdisciplinary teams with an industry partner on a 6-week project (with scholarship) during the thesis examination period.

The main drivers for developing iPREP were:

- increasing number of PhDs awarded in Australia with a diminishing number of academic places available for graduates
- PhD graduates not always prepared for careers outside the university
- Perception from industry that PhD graduates are overly specialised and lack key skills required for the workplace such as communication, teamwork, project management and business acumen
- Lack of short-term industry engagement programs that are appealing to businesses
- PhD students are 'in limbo' during the thesis examination period, making this an ideal time for them to undertake career development opportunities, such as an industry placement.

The iPREP concept was developed and trialled by Edith Cowan University in 2014. It has now been successfully run twice in 2015 as a state based program (iPREP WA) with the 5 collaborating Western Australian universities. The initiative continues to grow, with an agreement is in place to run three rounds of iPREP WA in 2016, highlighting the interest from both the university sector and industry.

Participants complete a two-day training program prior to commencing their placement. The program features expert guest speakers on topics including:

- project management
- communicating in a business context
- compliance with industry requirements
- collaborative leadership
- strategic problem solving
- social and emotional intelligence.

The student teams then undertake the 6 week project, mentored by their industry partner. All teams meet together weekly to discuss their projects, network and further develop their professional skills. At the conclusion of the project, each team is required to pitch their solution to the industry partner through an oral presentation and a short written report.

Following the conclusion of the program, a presentation evening is held where the students present their project findings as a 5 minute informal speech and receive certificates (presented by the Premier Colin Barnett in March 2015).

Program benefits

The concept of an industry engagement program after thesis submission is extremely valuable – from both the student and business perspective. Participating students have been from a wide range of disciplines, including arts, humanities, business and STEM backgrounds; which highlights the broad applicability of iPREP.

The main benefits reported by the students include:

- improved employability
- increased confidence
- greater business awareness
- new skills (e.g. project management)
- leadership development
- greater interdisciplinary understanding.

The interdisciplinary aspect was challenging at first for some students, but all found this highly beneficial to their development, with candidates commenting *'I was quite surprised at how easily I could conduct research in a new field'* and *'I was able to apply my understanding gained from the PhD into the real business world'.*

Industry partners reported that they received expert, unbiased consultation from experienced researchers who could help provide innovative and creative solutions to business problems. All businesses reported cost savings from the student team project, but wider benefits were also highlighted such as '*intangible benefits like expansion of our networks, linkages within a number of universities and an increased public profile'.*

Beyond these immediate benefits, we see the potential for iPREP to have a long term impact on both the career development of PhD graduates but also on building strong relationships

between universities and businesses. Interviews with industry mentors found that all businesses would be keen to establish further collaborations with the participating universities. We see iPREP as an excellent starting point for establishing significant, long-term relationships between universities and businesses, as the benefits of working with researchers can be demonstrated to the industry partner for only a small cash outlay and minimum administrative burden.

Summary of the collaborative approach

The iPREP WA Coordinator initially meets with interested organisations to explain the program and the types of projects that may be relevant to the needs of the company. Some of the participating iPREP organisations got involved due to existing partnerships with one of the universities; however most were new opportunities. Industry partners are responsible for the project concept and scope, and submit an Expression of Interest form that highlights the required skill sets and disciplines of the PhD candidates required.

Each university is responsible for promotion, call for applications from their eligible cohort, assessment of eligibility and referee check. The iPREP WA Coordinator collates all the eligible applications and does a preliminary allocation of PhD candidates to industry partner teams based on a skill set match.

The company then selects their preferred candidates for the project after reviewing CVs and undertaking interviews if required. Project agreements and invoicing are managed by the administering university (currently ECU), while each university is responsible for scholarship payments for their own PhD candidates.

The industry partner payment ranges from $5000 to $10,000 for a team of 3 PhD students for 6 weeks. Students are paid a $3000 scholarship for the 6 week program, which is administered by their home university, who also contributes 50 per cent of the stipend. The industry partner provides a mentor to work with the student team during the 6 weeks and also attends part of the induction program.

The iPREP WA Coordinator liaises with the industry mentor during the 6 week program to monitor the project progress and prepare promotional material.

A joint website has been established to promote the iPREP program and partners – see www.iprep.edu.au

Analysis of collaborative approach

The establishment of an overarching advisory board and brand that encompasses the 5 WA universities (Advancing Western Australia Research Education, AWARE) has been a critical factor in presenting a coordinated approach to the WA business community.

Having both the industry partner and the university of the participating student contribute to the scholarship and program costs ensures iPREP is a true collaboration. The scholarship is administered by the university the participating student is enrolled in, which helps reduce the administrative burden of the industry partner to encourage their involvement in iPREP.

The PhD candidates benefit from the collaboration between all 5 universities and the industry partners by enhanced employment and networking opportunities.

The promotion of iPREP and refinement of the program is still in development. Some potential partners who had submitted an Expression of Interest did withdraw from the program due to lack of relevant students applying, despite up to 50 candidates applying in one round. Future promotion of the iPREP will focus on targeted recruitment to the specific departments at each university based on the required skill sets from the interested partners.

Details and analysis of impact

Initial feedback from iPREP participants indicate that the program is achieving its overarching objective of enhancing engagement between researchers and industry. So far there have been 13 projects with 12 different companies engaging with 40 researchers.

More specifically, feedback from industry partners highlights the value PhD researchers can bring to their organisation. After participating in iPREP one organisation has subsequently submitted an ARC linkage grant involving 3 of the WA universities. In addition, the PhD students report that their employability has been enhanced by participating in iPREP.

Given that iPREP WA has been running for less than 12 months, the broader impacts of the program are yet to be realised. Some examples of the potential impact of iPREP WA include:

- additional collaborative activities undertaken between the industry partners and universities to enhance career development of HDRs e.g. mentoring schemes, scholarships
- joint grant applications (e.g. ARC linkage) between industry partners and the universities
- improved employment outcomes for PhD graduates
- increase in number of PhD graduates employed in non-academic settings.

Currently the evaluation of iPREP involves participants completing a short survey after the two day induction program and a one page reflection after the 6 week placement. Industry mentors are interviewed after the placement. iPREP industry partners and PhD candidates will be surveyed and/or interviewed 12 months after participating in the program to determine employment outcomes and additional collaboration activities. The data collected will enable continual improvement of the program, as well as an assessment of the longer-term impact of iPREP for enhancing engagement between industry and universities.

Collaboration is critical to the success of iPREP; both between the 5 universities and with the industry partners. Industry feedback highlights the value of engaging in a program with access to researchers from all 5 WA universities. We are also looking to further build on partnerships with State government departments and hopefully obtain Federal government support in the future. A coordinated and collaborative approach is critical to ensuring the program remains sustainable and contributes to innovation in the ‘knowledge economy’.

Federation University Australia — Centre for eResearch and Digital Innovation

Partners or end-users: Government departments (e.g. Victorian Department of Land, Water and Planning, City of Ballarat); Statutory corporations (e.g. Grains Research and Development Corporation, Goulburn Murray Water, CSIRO, Corangamite Catchment Management Authority); Private industry (e.g. Thiess Services Pty Ltd, Senversa Pty Ltd, Nicon Rural Services); end-users (e.g. Northern Growers Alliance, Liebe Group, Southern Farming Systems, Woady Yaloak Landcare Group).

Sector: Government departments, statutory corporations, private industry

Sources of Support: For the CeRDI projects profiled in the case study grants, direct investment, financial and in-kind support has been secured from the Government and the project partners listed at http://www.vvg.org.au/cb_pages/partners.php, Grains Research and Development Corporation, Corangamite Catchment Management Authority and City of Ballarat.

Purpose of Collaborations

Online Farm Trials Research ($1.75 million over 3 years from Grains Research and Development Corporation)

The extensive data available from farm trials research has previously been underutilised, accessible only via hard copy or basic electronic documents. The objective of the Online Farm Trials project was to help improve the productivity of agronomists and the sustainability of farming enterprises by providing online access to farm trial research information.

Key features of the research include: analytical tools for growers, agronomists and researchers; a digital library of national farm trial research reports and supporting documents; direct access to downloadable trial research data in digital form; linking of other sources of relevant trial research information; and increased networking and collaboration on cropping issues and farm trial research.

Visualising Victoria's Groundwater ($2.1 million over 3 years; funded by Victorian Government and multiple partners)

In many parts of the world the increased demand for groundwater for human consumption and food production has led to overexploitation of this precious resource. Further, because it is not visible, the nature of groundwater is often misunderstood and the subject of myth. In Australia, information and data on groundwater is available via various web-portals, web-based GIS tools, portable storage devices, hardcopy maps, theses, reports, newsletters, documents, videos and podcasts. Outside the research community these resources are largely ignored simply because of the difficulty of bringing the available information together to be able to answer the questions that guide decision-making for sustainable and equitable groundwater use.

To address many of these issues, CeRDI has developed spatial data infrastructure which interoperably federates groundwater data from disparate database sources into a single platform. Visualising Victoria's Groundwater (VVG) provides centralised access to Victoria's ground water information for decision making. VVG consolidates data from over 400,000 bores from four authoritative sources together with Victorian aquifer information with features that include 2D and 3D visualisations, hydrogeological models and historical records and maps.

Soil Health and NRM Planning ($0.2 million over 3 years from Corangamite CMA)

Soil health is necessary for food production. Soil health issues have recently been documented in the Corangamite region of Victoria in *Soils Vision: A 20-year plan to improve broad-acre agricultural soils in south west Victoria*, known as the 'south west agricultural soils plan' (SWASP). The Corangamite Catchment Management Authority (CMA) recognise the need for SWASP to be integrated into catchment management plans that are developed for each of the 15 Landscape Zones in the Corangamite region. Each Local Catchment Plan (LCP) has a unique set of soil health issues and management history that relates to the local landscapes.

The aim of this research was to provide stakeholders with the essential background knowledge required to implement the appropriate SWASP soil health actions customised for the LCPs and to develop a comprehensive, accessible knowledge base of soil health information to assist the broader community to recognise the values of the soils of the Corangamite region.

Providing access to a directory of documents and a database of information was considered necessary though not sufficient. Such a repository needed also to be spatially enabled, allowing users to focus on their patch and provide relevant and informative answers to their questions via an intuitive-to-use web-portal. This dissemination of soil health information required spatial and content synthesis to maximise its usefulness.

Historic Urban Landscapes and Visualising Ballarat ($0.1 million over 2 years from the City of Ballarat)

Local Governments across the world face challenges in urban planning and managing growth without compromising the character of their cities' natural landscape and cultural heritage. CeRDI has partnered with the City of Ballarat's in the Historic Urban Landscapes (HUL) UNESCO pilot program to provide a road map supported by innovative online technologies to engage the community in addressing change without losing Ballarat's character. UNESCO's values-based approach involves working collaboratively with communities; the Ballarat Historic Urban Landscape portal enables engagement with the Ballarat community and assists the City of Ballarat to realise the significant and essential role Local Governments play in protecting and enhancing the urban landscape as well as promoting inclusive and participatory planning.

Collaborative approach

Whether the organisation is a large statutory corporation or a relatively small local community group, CeRDI effectively builds long-term relationships, commencing with short pilot projects to demonstrate what can be achieved, and continues to influence the organisation to embrace the application of digital technologies in its thinking and longer term planning.

Many of the collaborative partnerships began from the interactions between a representative or group within a particular industry and an individual within the CeRDI team. During the initial stages of engagement, ideas were developed and demonstration projects commenced which led to broader visionary programs involving multiple stakeholders within that industry.

For example, Online Farm Trials Research is one of several projects with the Grains Research and Development Corporation (GRDC). The relationship with GRDC has been sustained for more than ten years. It commenced with an introduction from the Birchip Cropping Group, a regional grower group in Victoria with which CeRDI had completed several smaller, innovative knowledge management projects. With Online Farm Trials Research, CeRDI influenced GRDC to expand its original concept of a standard digital library to instead develop a research and knowledge management approach which allowed access to trial data and enabled priority questions for agronomists and growers to be answered. CeRDI engaged with industry experts and successfully completed demonstration projects with grower groups in all GRDC zones. These successes and the resulting support from the grower groups provided GRDC with a greater appreciation of CeRDI's capabilities. This led to a larger programme of work, adding further depth to the longer-term partnership.

VVG was the culmination of a staged approach in which CeRDI brought together a number of partners from the water industry. The VVG collaboration involved 15 organisations within government and the water industry. It has been successful because CeRDI research and technical staff understood the requirements of the stakeholders, then developed the program of work to realise the stakeholder's shorter term objectives (with corresponding beneficial outcomes) while recognising that CeRDI's longer-term research objectives would also be achieved. The partnerships have been sustained through delivering the desired outcomes; in particular CeRDI ensured that the capability to answer the partners' questions, e.g. the depth to groundwater and groundwater quality, were achieved as soon as possible, without waiting for all groundwater data to become available. In addition, frequent progress communications and periodic face-to-face meetings helped to nurture and sustain the partnerships.

The Soil Health and Natural Resource Management Planning project came about as part of a ten-year collaboration between CeRDI and the CCMA. The initial engagement with CCMA commenced with a small online knowledge management project. CeRDI continued to engage with the CCMA, its committees and stakeholders, including end-user groups, which formed part of the broader community involved in catchment planning to understand their objectives. CeRDI then developed ideas and innovative approaches to show how digital technologies may be used to help achieve these objectives, coupled with broader research programs. Previous successful and ongoing CeRDI projects with CCMA have included the

Corangamite Groundwater Bore and Research Database, the Corangamite Erosion and Landslide Database and the Corangamite Knowledge Base.

The Historic Urban Landscapes project expanded the initiatives already underway by the City of Ballarat to preserve Ballarat's cultural heritage and history as part of the City's participation in the UNESCO pilot program. CeRDI had also contributed to work in this area by bringing digitised and historic Ballarat maps and archival collections together online in collaboration with historians at FedUni's Geoffrey Blainey Research Centre. Through relationships with people already engaged with the City of Ballarat initiatives, CeRDI proactively influenced those involved about the wide application of eResearch and digital technologies, coupled with CeRDI's vision for innovations using spatial mapping tools and knowledge management approaches. When a symposium was held to drive implementation, CeRDI's approaches were written into the recommendations, resulting in the CeRDI collaborative partnerships being formalised. These partnerships have been sustained by CeRDI interacting with stakeholders to understand their objectives and needs, the completion of demonstration pilots that appealed to the end-users and the recognition that CeRDI was delivering beneficial outcomes to the stakeholders and the broader community.

Analysis of collaborative approach

CeRDI's approach and sustained success in building productive collaborative partnerships is based upon a research and engagement model characterised by a number of factors, including:

- fostering a culture of excellence, partner engagement, knowledge transfer and the building of long-term collaborative partnerships based upon good will, trust and credibility
- prioritising a high level of co-creation through close linkages and engagement with researchers, government, industry and the broader community; this catalyses knowledge mobilisation and ensures beneficial outcomes for partner organisations
- knowledge transfer to build capacity within the partner organisation and increase their capabilities to achieve their objectives; this is facilitated by embedding partner personnel with CeRDI and CeRDI personnel with the partner organisations
- the application of digital technologies and continuous innovations in e.g. interoperable systems, spatial mapping, knowledge management, publishing and participatory geographical information systems
- the ability to understand the organisations' needs, and to provide creative insights into how these needs may be met through the use of eResearch and digital technologies
- the use of pilot projects to demonstrate to the partner organisations what may be achieved
- ensuring that outcomes are delivered in a timely fashion to the partner organisations that benefit the end-users for whom the partner organisation is providing services
- the multidisciplinary nature of the CeRDI team, with its mix of technological, research and discipline expertise; where additional discipline expertise is required CeRDI will establish collaborations to access the necessary expertise

- a commitment to longitudinal research to measure the impact of eResearch and digital innovations undertaken by CeRDI.

Details and analysis of impact

Visualising Victoria's Groundwater

VVG is being used by water users, resource managers, landowners and conservation groups to inform their decisions about managing consumptive water use and environmental water flows. The societal impact of the VVG web portal was measured using multidisciplinary research that employed survey instruments, expert reference groups, and internet analytics to explore the extent to which the web portal has supported decision making and practice change across government, industry, researchers and the community.

The research found that VVG provided timely, informed and accurate information in response to queries. The research concluded that VVG has changed practices in the Victorian groundwater industry.

Through VVG, CeRDI has developed methodologies to enable the interoperable exchange of data. CeRDI is collaborating with CSIRO and BoM to develop international standards and participates in the international Open Geospatial Consortium working groups in areas including the Groundwater Interoperability Experiment 2 and the International Soil Data Interoperability Experiment.

CeRDI has received industry recognition for its work on VVG e.g. CeRDI was awarded the 2013 iAwards Victorian winner (Regional category) and a 2013 iAwards National Merit recipient.

Online Farm Trials Research

This project has led to improved agricultural knowledge dissemination approaches and significantly changed the way research results are made available so agronomists and growers can make better, more timely and more profitable decisions e.g. Southern Farming Systems have used Online Farm Trials to decide whether achieving malt quality barley or maximising feed quality yield would be more profitable in the high rainfall zone of Victoria. The impact for GRDC is enhanced access to, and use of, the results of past research and more rapid implementation of research results (extension).

Soil Health and NRM Planning

The innovations in the Corangamite Soil Health Knowledge Base project which facilitate the engagement of community stakeholders in catchment management and planning have led to CCMA's approach to catchment management and natural resource management (NRM) planning being recognised as exemplary. The integrated technologies developed by CeRDI enable Citizen Science approaches and the empowering of Landcare networks, community groups and stakeholders to identify joint priorities for partnerships in catchment management (with Corangamite CMA). Victoria's Commissioner for Environmental Sustainability has publicly acknowledged this work as exemplary, with planning underway for state-wide adoption.

The Corangamite Soil Health Knowledge Base received a 2015 Victorian Spatial Excellence Award in the Environment and Sustainability category.

Historic Urban Landscapes and Visualising Ballarat

Longitudinal research on the impact of the HUL and Visualising Ballarat web portal was recently commenced. The findings of the first wave of this research attest to the value of the HUL web portal as an effective mechanism for community engagement, knowledge building and planning. Moreover the portal has enabled greater exploration of the options and opportunities for building interest and commitment to the broader HUL initiative. The Historic Urban Landscape (HUL) and Visualising Ballarat project received the Victorian Spatial Excellence Award for People and Community.

Flinders University — The Medical Device Partnering Program

The Medical Device Partnering Program provides a unique model for collaboration between researchers, end-users and industry to develop cutting-edge medical devices that solve real problems. The success of the program has been recognised both within South Australia and nationally.

The Medical Device Partnering Program

The Medical Device Partnering Program (MDPP) represents a successful example of a structured approach to university / industry engagement and collaborative product development in an industry where collaboration is difficult due to a predominance of small to medium enterprises (SMEs).

This award-winning Program:

- brings together a network of stakeholders in the medical device development process, ensuring practical developments that meet a market need or problem
- facilitates new, targeted partnerships between research organisations, end-users and companies
- provides a non-competitive environment for research collaboration across research institutions
- provides practical assistance in taking ideas closer to the market.

Since the program was launched in 2008, the MDPP has had enquiries from over 300 Australian medical device companies and inventors. The MDPP has provided assistance to 160 of these, with prototype development; proof-of-concept or validation studies; expert technical advice; end-users or market advice; and introductions made for product commercialisation.

The MDPP model provides a transparent and reliable model of engagement between research and industry that has a strong and proven track record of successful outcomes.

Award-Winning Program

- 2011 Business/Higher Education Round Table (B-HERT) award for Best Research & Development Collaboration nationally
- 2010 Technology Industry Association Excellence Award for Service to the Electronics & ICT Industry
- Finalist, South Australian Science Excellence Awards 2010 for Excellence in Research Collaboration

The MDPP is possibly the best model for fostering university Industry collaboration that I have encountered in an Australian University (Dr Steven Farrugia, Vice President Technology, ResMedLtd)

*The MDPP has, and is, successfully breaking through traditional cultural differences and provides a pathway for companies and theUniversity to communicate and work together in a way that was previously achieved only rarely. (*Andrew Riggs, Healthcare Industry Development Manager, Innovate SA)

In brief, the MDPP works as follows:

- During initial stages of the partnering process, the MDPP Team works with the client company to identify opportunities for collaborative product development.
- Opportunity mapping includes a project workshop with the client, up to 10 multi-disciplinary specialists, manufacturers, regulators and end-users. The workshop explores and aligns commercial and market opportunity with technical and research feasibility.
- Approved opportunities progress to carefully structured technical exploration projects which may involve prototype development, proof of concept work, product validation or evaluation.

The commercial partner provides a cash co-contribution to the project and in return they receive unencumbered all results, data, prototypes and intellectual property together with a plan for future research, development and/or commercialisation.

Benefits to industry include leveraging cost of research activity, reducing risk in the innovation process, substantial value-add through access to MDPP research partner expertise and building strong relationships through meaningful and mutually beneficial interactions.

Researchers benefit from enhanced industry collaborations, potential access to future research funding, building strong relationships with industry and increased relevance of medical device research activities.

Award-Winning Leadership

MDPP Director, Professor Karen Reynolds has received a number of awards including:

- 2014 the Medical Technology Association of Australia's Outstanding Achievement Award for contributions to the industry
- 2010 named as Australia's Professional Engineer of the Year.

A new model for collaboration

- based on relationship-building
- simplified collaboration process — transparent intellectual property and contractual arrangements
- driven by market pull rather than technology push
- open to all SMEs including start-ups or inventors
- sector-focussed so that networking and knowledge of the industry sector is developed to enable fast connections
- timely responses — days, not weeks
- encourages local manufacturing opportunities rather than off-shore licensing arrangements
- provides a portal to appropriate research expertise, and identifies research value-add
- brings a multi-disciplinary approach to product development.

Unfortunately for SMEs, there is neither a single model for interaction with a particular institution, nor a single clearing house representing them all. The task for SMEs in identifying, contacting, learning how to deal with and successfully negotiating collaboration or technology transfer deals with a particular RO is too time consuming for most to justify.

AIC Discussion Paper -'Overcoming the Industry -Research Sector Divide'

Program expansion

The MDPP is primarily aimed at delivering benefits to South Australia in the first instance, as it is supported through the South Australian Government. Proving a benefit to South Australia is a criterion for entry into the MDPP.

With additional support there is considerable potential for expansion to benefit other Governments. These benefits may include increased innovation, better linkages across the medical devices sector, and increased employment.

The Medical Device Industry in Australia

- Turnover of approximately $11.8 billion in 2012-13
- Employed more than 19,000 people
- Imported goods to the value of $5.59 billion
- Exported goods to the value of $2.23 billion
- Dependent on an advanced manufacturing supply chain
- Market drivers include: the ageing population, increased expectations for quality of life, growing demand in Asia
- An SME-dominated industry (60 per cent of medical device companies employ less than 20 people)
- Highly regulated, but relatively short time to market
- Innovative, highly diversified, competitive
- High research expertise, poor innovation history
- Need for improvement in collaboration between research institutions and local industry identified in many reports

Case Studies

The MDPP adds value to the medical device development process at all stages of product and company development.

Start-up Companies

MDPP works with start-ups to provide concept models, undertake feasibility studies, or establish product viability.

- MDPP provided INNOVO Healthcarewith industry feedback, a clinical trial and a detailed market research report for their product 'U-Stand Frame', a device that assists patients and aged care residents in sit-to-stand transfer. The MDPP also made introductions to a local manufacturer resulting in a recent launch of the product on the market. The U-Stand Frame has been selected as a finalist in a global startupcompetition to be held in the US in November.

Early Stage Companies

Early stage companies often need to independently validate their product to gain TGA approval and to improve sales and marketing outcomes.

- MDPP, together with research partners at the University of South Australia, worked with StaminaLiftto provide independent validation of their hospital bed mover. The data generated were used as part of a global marketing campaign resulting in sales in the UK, Europe, Middle East and Canada.

Case Studies

Established Companies

MDPP has assisted established companies by investigating new product opportunities.

- MDPP worked with ResMed, a world leader in sleep apnoea, to identify wider applications for their sleep apnoea device. This resulted in a patent application by ResMed, and an ongoing research collaboration between ResMedand Flinders University.
- MDPP worked with Austofixto develop their Ezy-Aim device which removes the need for multiple x-rays when fixing bone fractures. This product is now being manufactured locally and sold internationally in Asia, Europe and the Middle East. The product has received international acclaim from orthopaedic surgeons across the world.

Technology Transfer & Spin-outs

MDPP works with University commercial arms to assist in the commercialisation of University-based research.

- MDPP developed a working prototype for a sleep disorder device for spin-out company Re-Timer Pty Ltd, and introduced the company to a local manufacturer. Re-Timer has now been sold in more than 40 different countries worldwide and is the world's number one selling wearable light therapy device.

Griffith University — MAPP Pilot Education Program

Partners and end-users

Griffith University, Air New Zealand Group, QantasLink and RAAF, private sector and government

Sources of support

Australian Competitive Grant Funding:

- ARC Linkage Grant (LP140100057 - Mavin, T.J., Roth, W-M., Munro, I, Wallace, G, & Cook, B. (2015-17). Understanding and improving pilot learning and development at critical stages of their career).

Commercial Research / Consultancy Engagements (> AUD 1.2 million):

- Air New Zealand, QantasLink & Royal Australian Air Force (Mavin, T.J. (2015/8). Developing unified training and assessment solutions for airline pilots.)
- Qantas New Zealand (Mavin, T.J. (2014/7). Integrated research solutions for pilots.)
- Air New Zealand (Mavin, T.J. (2013/5). Developing integrated learning solutions for pilots.)
- QantasLink (Mavin, T.J. (2013/4). The use of enhanced methods of instruction for pilots.)
- Jetstar(Mavin, T.J. (2012-14). MAPP.)
- Air New Zealand (Mavin, T.J. & Bryant, P. (2012/13). Use of synthetic training environments for predatory training in pilot training.)
- Defence Science and Technology Group (Mavin, T.J. & Bates, P. (2011). The Use of Simulation in Initial Flight Lessons.)

Historically, pilot training focused on flying skills and associated aircraft knowledge. Even with the introduction of jet aircraft, this training approach has seen little change. These skills and knowledge — often referred to as 'technical skills' — have been identified as critical to improvements in aviation safety. However, accident inquiries over the last 50 years have illustrated a change in the percentage mix of pilot-versus machine-related accidents. Improvements in aircraft engineering, design and technology now have pilots implicated more frequently in aviation accidents. Associate Professor Tim Mavin has designed and implemented a new training and capacity identification program called MAPP (Model for Assessing a Pilots Performance) to overcome this important safety concern and make pilots better decision-makers and create better communications and management systems.

Was there a particular solution to be achieved?

Research indicates a majority of accidents are not related to pilots' technical skills — such as flying skill — but rather, cantered on areas such as communication and decision-making. Investigations reveal a mismatch between traditional training and assessment methods, and causes of accidents, highlighting an important need for changes in pilot training and assessment. Over the last decade (in Australian and New Zealand for the last four years), the

international aviation industry has initiated an emphasis of training and assessing pilots in technical and non-technical skills. A/Prof Mavin's studies focus on investigating and improving how these skills are taught and assessed in aviation, and more recently in other aviation professionals such as air traffic control and engineering.

Summary of collaborative approach

A/Prof Mavin spent 22 years as a professional pilot, firstly with the RAAF, then as an airline pilot before transferring into education, civil aviation safety authority, and then finally academia in 2008. He remains today a practicing Boeing 737 flight simulator instructor, where he trains pilots from numerous airlines around the world.

During his time as an airline pilot, Mavin identified a major lack of educational expertise within aviation, leading to him to return to University to qualify as a vocational and high school teacher. These underpinning educational skill sets, coupled with aviation expertise, has enabled him to become a valued educational expert in aviation. For example, the global airline industry is expecting a significant rise in the number of people flying over the next 20 years. Just to meet global demand, airlines are expected to train 160,000 new pilots over the next 20 years. Beyond safety, in a high volume, low margin industry effective pilot training can make a big difference to long--term productivity and profit. He and his partners are acutely aware of the need for 'real--world' solutions for practical and important issues that potentially involve the safety of hundreds of people. Airlines hire A/Prof Mavin to design competency assessment and education programs for pilots to improve and streamline pilot training.

Was there a pre-existing partnership? How long has it been in effect?

Associate Professor Mavin's partnerships began as extensions to his 22-year flying career. They were deepened by his Doctoral studies research and the successful application of his results since this time. As A/Prof Mavin's publishing and testimonials indicate, much of his research has been dedicated toward providing his partners with solutions that improve pilot competency and passenger confidence.

What were the mechanisms employed to implement and manage the collaborative processes?

The partnerships established by A/Prof Mavin are commercial research/consultancy engagements supported by Griffith University's Commercialisation and Innovation Office, Griffith Enterprise. This internal University initiative supports A/Prof Mavin in structuring and costing external engagements, facilitating the respective contractual arrangements. With his expertise and skills as an airline captain, A/Prof Mavin has the capacity to mage projects in collaboration with industry and governmental partners.

What were the contributions of each party? Were they appropriate and effective?

Griffith University provided research capability and credibility in both training and understanding the needs of the airline industry and pilots. We were able to assemble an excellent team across the research field and through the work of Griffith Enterprise create business agreements beneficial to both parties. This built the essential trust between the institution and the airlines necessary for a productive relationship to find solutions.

The airlines provided the problems and were open-minded to finding new ideas or even revisiting old ones. They were committed to finding solutions and backed this commitment by proving technical, financial and human resources. The Griffith team were given access to equipment and information airlines traditionally guard closely.

What was most successful element of the collaborative approach?

In 2012 Air New Zealand sought A/Prof Mavin's advice on probable issues relating to pilots flying differing aircraft types. A new aircraft, the Airbus ATR72-600 was introduced. It is an updated flight deck version of the older ATR72-500. The concern was that even though international regulations allowed for pilots to fly both aircraft without further training, there appeared to be resistance from the pilot group. At the time Air New Zealand was already engaged with Griffith University under a research agreement, enabling A/Prof Mavin to design a modified think-a-aloud study to investigate likely problems pilots might face. Using company pilots and the company high fidelity simulators, A/Prof Mavin's team identified key issues pilots would have during transition. Based on his report to the company and publication of those findings (Mavin, Roth, Soo & Munro, 2015) the airline made an informed, though more expensive decision, to disallow 'mixed fleet flying' (See attached testimonial from Mt Cook Airlines).

What lessons were learnt for future/ongoing collaboration?

This partnership is ongoing but has also fed into other collaborations with Qantaslink and RAAF. What is being progressively harnessed is the possibility of transferring MAPP to other industries. The partnership between A/Prof Mavin's group and Griffith Enterprise continues to explore this possibility.

How well did the programme/project achieve its objectives?

The partnerships established by A/Prof Mavin have been enormously successful for all parties. The airlines have a highly credentialed research and training partner and the University has established deep and trusting links with an industry we directly support through one of the few undergraduate pilots programs in Australia.

What has been the impact of the programme/project (social, economic, commercial, community and/or other impacts)?

There have been three orders of significant impact through the partnership. The first has been the research impact, as evidenced through A/Prof Mavin's strong publishing record over the last six years through books, journal articles, chapters and PhD students.

The second has been the development of a model for assessing a pilots' performance (MAPP). The MAPP is a practical educational system that assists in assessing complex work domains, such as the flight deck of a modern commercial aircraft. This new assessment system has benefited the pilot cohort in their ability to reflect and learn from their own performance. From a company's perspective they have documented a continual decrease in piloting errors and improved outcomes in safety management. The training system that A/Prof Mavin has helped to implement has attributed to this improvement. According to the airlines this has improved pilot skills, safety and saved the airlines significant cost.

Thirdly, benefits for the whole industry and community have arisen from the increased safety and confidence of better trained and assessed pilots. Furthermore, the MAPP program will be adapted to other occupations in high-stress, hi-impact industries, where decision making is complex and are based on multiple information streams. It will improve the safety of people dependent on these professionals and the community's confidence in their abilities. In testimonials provided by A/Prof Mavin's partners, improved cost-effectiveness of training was highlighted. Australia has long struggled to maintain a competitive, high-quality airline industry, despite our utter dependence on such an industry. The MAPP program allows pilots to be more flexible and management to be more efficient in the development of systems on which the industry rests - safety.

How do you measure/evaluate the programme's impact? What was the time frame?

Because the research has immediate and practical outcomes, success is measured by the improved performance of pilots and the improved decision making ability of an airline or air force. Both methods and impact analyses have been provided in multiple published studies available on request.

Is there likely to be on-going impact?

As A/Prof Mavin's partnerships are ongoing and expanding, immediate impact will continue. With expansion into other industries, MAPP's impact will significantly increase.

Have there been any evaluations and/or follow up studies of the programme/project?

As outlined, earlier evaluation is inherent to the system and partnership. The airlines and RAAF are able to immediately evaluate the success of the programs and would discontinue the partnership if the programs were unsuccessful. All partners provide glowing recommendations of A/Prof Mavin and the MAPP program.

Is there any specific data or other evidence of academic or other impact (e.g. citations, patents, start-ups, ongoing or long-term collaboration arising from the programme)?

Academic data is available through PubMed, details partnership funding have been included above. The partnerships can also be measured in the significant resources contributed by the airlines and air force and the development of MAPP, which could be adapted to many other high-tech industries.

How did the collaborative approach contribute to the impact?

The major success of MAPP has been the partnerships that have driven it. None of it would be possible without the full commitment and trust of the industry partners, nor could A/Prof Mavin's agreements have been so positive without the business expertise of Griffith Enterprise, with whom Tim has been engaged throughout the partnership. The collaborative approach did not contribute to the impact it was the whole process from start to finish.

James Cook University — How algae researchers are working with business to transform the aquaculture industry in North Queensland

The information provided is based on a forthcoming article in BHERT Magazine[1]

Key points

- JCU has a well-established research program with Melbourne-based MBD Energy that conducts R&D on a wide range of products and processes using algae including bioremediation, feedstocks and biofuels. Previous work also included carbon capture and storage technologies.
- Current work in commercial application includes:
    - Treatment of water to minimize environmental impacts of aquaculture (see below)
    - Municipal waste water remediation facilities, e.g. 80,000l plant at Townsville City Council's Cleveland Bay Waste Water Purification plant.
- The aquaculture technologies have been rolled out in a number of large prawn farms in North Queensland and exported to China and Thailand with sites in Vietnam well into negotiation.
- The partnership has attracted $40 million of private investment and $30 million of Commonwealth and State Government funding, including Australian Biofuels Research Institute (ABRI), Australian Renewable Energy Agency (ARENA), CRC and Queensland Smart State.
- Trust and clarity of expectations between the partners have been central to the success of the collaboration.
- For industry, they have had access to world-leading R&D that is responsive to needs and timeframes.
- For JCU, the partnership represents a clear research agenda that has significantly enabled PhD research education and the production of high quality peer reviewed publications, as well as enabling career pathways and mobility of staff and students between sectors. Both JCU and MBD have benefited from shared investment in infrastructure.
- Lessons learnt? Key lesson is the importance of building trust and understanding expectations with a long-term view. The multi-factor returns on patient capital are significant and compelling.

[1] JCU gratefully acknowledges this information was prepared by the IRU for a forthcoming article in BHERT magazine.

‘An exemplar of long term university and industry cooperation’

The employees of Pacific Reef Fisheries, a prawn farm in Ayr, North Queensland are not the only ones working today — the algae in the prawn ponds will continue their daily grind of absorbing the nitrogen and phosphorus in the waste water. The enterprise represents a world-class sustainable aquaculture facility. Not only is this algae (seaweed) a potential export in its own right, the purified water can be returned back to the ocean without causing any damage to the Great Barrier Reef.

The Great Barrier Reef Marine Park Authority (GBRMPA) stipulates that for new prawn farms the level of nitrogen and phosphorus in the discharge water going back to the Great Barrier Reef waters must not be higher than the levels in the inlet water. This has meant that the North Queensland prawn industry has not expanded in the last ten years.

Now, thanks to technology developed by Melbourne-based company MBD Energy in partnership with researchers at James Cook University, it is possible for Australia’s largest prawn farm business Pacific Reef Fisheries to meet this requirement. MBD is the first company in the world to commercialize algae as a water treatment option using this technology.

It all started in 2008 when MBD was seeking the research expertise to develop its technology. ‘We wanted to focus on Australia. We were sure that the research was out there,’ says Mr Andrew Lawson, Managing Director of MBD Energy. ‘In the end, the Queensland State Government was crucial in linking us to the right partner.’

Professor Rocky de Nys at the College of Marine and Environmental Sciences at James Cook University had the necessary expertise. With an established track record of working with industry, Professor de Nys was the ideal match for MBD. Before long the first stage of the $250,000 trial project was underway. Since then more than $40 million of private equity and $30 million in government support have been invested.

Mr Lawson described working with such world-leading researchers as inspiring. Actually seeing the ideas work in practice was a benefit and motivation for MBD and JCU.

The key to this successful joint venture has been continuous open and honest communication. As Professor de Nys explains, ‘It is important for both sides to clearly communicate what they want to get out of the relationship. For instance, from the academic side, publications and PhD completions are essential.’

Professor de Nys now leads a team of 30 researchers focusing on algae research. It is not just the connections with industry which have flourished. Professor de Nys estimates that as a result of this collaboration, around 20-30 academic papers are published each year in international journals significantly increasing industry knowledge and practice. ‘Having such work peer-reviewed and at the highest possible academic standard is of huge benefit to the wider industry.’

In its statement 'Industry Driven Research'[2], the Innovative Research Universities (IRU) group, of which James Cook University is a member, calls for enhanced incentives for industry as the first step towards increasing industry driven research in Australia.

Asked about incentives, Mr Lawson describes the R&D tax incentive and other government programs to help a company in the pre-commercial stage as critical. Funding from government mitigates the risk for the industry partner — a crucial factor for SMEs. Another important point is having the research available in Australia. From the both the company and university's perspective having the right systems in place to ensure Intellectual Property (IP) is protected is a priority. Professor de Nys highlighted the usefulness of working through the Advanced Manufacturing Co-operative Research Centre which provides the opportunity for top-up scholarships for students.

Both Mr Lawson and Professor de Nys consider the PhD completions as an important and highly valued outcome of the collaboration. Some of the PhD students went on to work with MBD. High-achieving international students are also attracted to JCU by the opportunities that the partnership offers

So what are the plans for the future? Mr Lawson confirms that the partnership has been extended for a further 20 years to support the commercial rollout of projects. In addition, the technology is being used in other spinoff industries such as the sugar cane industry. Meanwhile leading aquaculture countries such as Thailand, Vietnam and China are working with MBD to expand the technology in Asia. The R&D facility at JCU will continue to support this expansion with ongoing research and development, knowledge, training and expert support to MBD's commercial activities.

As the demand for clean technology with minimum impact on the environment increases, the potential growth sectors for this technology are manifold. This year Professor de Nys and Dr Nick Paul won the United Nations Association of Australia (UNAA) World Environment Day award for the ground-breaking research of using algae to treat wastewater. The UNAA commended the project as an exemplar of long term university and industry cooperation.

This is a clear example of research of excellent quality being commercially viable. IRU has put forward a proposal calling for a way to assess this kind of research to ensure universities and researchers are recognized for these achievements[3].

Asked about the main challenges since the project's inception, Mr Lawson said that when the carbon tax was removed, some staff members had to be repositioned. Businesses need flexibility to respond to changing circumstances and this was a lesson learnt for both sides which sharpened the focus of the research more closely with the expected project outcomes.

---

[2] http://www.iru.edu.au/media/54104/industryper cent20drivenper cent20researchper cent20-per cent20iruper cent202015.pdf

[3] http://www.iru.edu.au/media/55230/measuringper cent20researchper cent20valueper cent20forper cent20externalper cent20users.pdf

Much has been said of a clash of cultures between industry and universities, however in this case, a mutual understanding of each other's objectives enabled research and commercial outcomes to align, and a percentage of the profit goes back to the university. Post-doctoral research staff have the necessary technical support to swiftly turn around industry questions, with postgraduate students undertaking more blue-sky research. MBD understands and values the academic outcomes, like journal articles and research training. As Professor de Nys puts it, 'Basically both sides must show flexibility.'

Macquarie University — Studies of emissions produced during thermal processing of iron ores

Partners or end-users: Hamersley Iron Pty Ltd., a subsidiary of Rio Tinto

Sector: British-Australian Private Industry

Sources of Support: Major collaborative research funding in support of this research:

- 2008-2010 Strezov, Nelson, Gulson, Evans, “Thermal and environmental investigation of particle degradation during high temperature processing of iron ores”, ARC Linkage Project, Hamersley Iron and Macquarie University Research Excellence Scholarship ($585,300)
- 2011-2014 Strezov, Nelson, Evans, “Atmospheric Emissions of Toxic Trace Metals and Volatiles during Thermal Processing of Iron Ores”, ARC Linkage ($460,000)
- 2014-2017 Strezov, Frost, Nelson, Evans, “Hot stage separation of non-ferrous fraction during iron ore reduction” ARC Linkage ($330,000)

In addition to these ARC grants, substantial additional direct financial support of over $200,000 has been provided to this research program from RIBG funds, AINSE Awards, Australian Coal Association Research Program. Considerable support has been provided by the industry partner through the provision of laboratory equipment and facilities located within the University.

Purpose of programme/project

What was the problem or issue being addressed?
Was there a particular solution to be achieved?

Macquarie University has had a long standing partnership with Hamersley Iron Pty Ltd, a wholly owned subsidiary of Rio Tinto. This partnership has focused on understanding the various potential impacts from the iron ore processing industry. For example, the project has investigated emissions produced from iron ore processing. Processing iron ores has the potential to release toxic volatile compounds and particulates into the atmosphere. Obviously any such emissions should be minimised.

Understanding emissions, their composition, the mechanisms leading to emissions, and differences between different ore samples is a priority for the industry. This program answers important industry questions such as:

- which are the lowest emitting ore?
- how to economically separate and recover high-value non-ferrous impurities from the ore?
- how to reduce waste?
- how to improve the quality of the final metallic iron product?
- how to enable utilisation of iron ores that currently are not commercially viable due to their high impurity levels and low iron contents?

In earlier stages of this program, in partnership with Hamersley Iron, Macquarie University researchers studied emission of particles during processing and explored how particles were formed and which ores produced the most particles. A key concern was to understand the chemical composition of the particles. This work was followed by a project that looked at the volatiles released during processing and how such compounds are produced, including the material loss on ignition. This important work revealed that the International Organization for Standardization (ISO) standards underestimated the loss on ignition. Recommendations developed within this program are now used by Hamersley in reporting loss on ignition.

Summary of collaborative approach

What was the nature of the partnership/collaboration?
Was there a pre-existing partnership? How long has it been in effect?
What were the mechanisms employed to implement and manage the collaborative processes?

Over at least seven years, there is a deep and continuing research partnership between Macquarie University and Hamersley Iron. The partnership has now grown to the point where the key collaborator at Hamersley Iron is now an Adjunct Professor at Macquarie University illustrating the importance of true engagement between staff in universities and industry partners.

Analysis of collaborative approach

What were the contributions of each party? Were they appropriate and effective?
What specific steps or activities were taken to support/achieve mutual interests and benefits, due to the different organisational drivers?
What was most successful element of the collaborative approach?
What lessons were learnt for future/ongoing collaboration?

Staff from Hamersley Iron led by Dr Tim Evans, Principal Engineer are deeply committed to and fully engaged with the research program at all levels including co-authoring publications arising from the research partnership, and industry co-supervision of postgraduate research students.

The partnership includes substantial direct and in-kind support from Hamersley Iron including providing a substantial investment in research equipment and facilities provided on long term loan to the Macquarie University research laboratories managed by Professor Strezov.

The most successful element of the collaborative approach would have to be the genuine involvement of the industry partner in the actual research program, rather than being solely interested in the results of the program. This has allowed the industry partner and University to work together to define fruitful areas of research for mutual benefit.

An ongoing research partnership challenge is finding research areas where the academic and industry interests come together. Overcoming this challenge has allowed both parties to

develop a deep relationship and pursue new but linked research areas of mutual interest. Bringing in a key researcher from the industry partner to be appointed as Adjunct Professor has greatly facilitated this collaborative and productive research partnership. The industry partner's interest in the core science as well as the practical results of the joint research program has been a fundamental element of the successful collaboration. The researchers have worked hard to understand the industry issues and to develop approaches that provide practical solutions without ignoring the fundamental science required. They have also developed creative ways to leverage industry funds with funding from other sources to optimise the outcomes.

Details and analysis of impact

How well did the programme/project achieve its objectives?
What has been the impact of the programme/project (social, economic, commercial, community and/or other impacts)?
How do or did you measure/evaluate the programme's impact? What was the time frame?
Is there likely to be on-going impact?
Have there been any evaluations and/or follow up studies of the programme/project?
Is there any specific data or other evidence of academic or other impact (e.g. citations, patents, start-ups, ongoing or long-term collaboration arising from the programme/project)?
How did the collaborative approach contribute to the impact?

The research program has been very successful as evidenced by the continuing strong partnership between Hamersley Iron and Macquarie University. The strength of the partnership has enabled the research team to win two consecutive bids for ARC Linkage Project funding, built upon the foundations of the first.

The projects have provided industry and academic training for research assistants, PhD students and post-doctoral researchers in an industry of vital importance to Australia.

For example, the program has directly influenced the operations and management practices of the Rio Tinto iron ore group, including a redesign of the Loss on Ignition reporting and assessment standards used to estimate amounts of impurities in iron ores. The new internal Hamersley standard has been promoted internationally and within the relevant international ISO committee. In more recent work, research conducted within the collaboration has identified several trace elements of specific interest for improvement of pollution in processing of iron ores. These findings have implications nationally and internationally, for example understanding the contribution of iron making processes to pollution in China.

The relationship has broadened beyond the two partners and now includes Macquarie University's partnership in the $5 million ARC Research Hub for Computational Particle Technology led by Monash University.

Monash University — Chemicals & Plastics Innovation Network and Training Program

Partners or end-users: 20 partners including: PACIA (lead industry partner), 3M, Agilent Technologies, Axieo, BASF, Dulux Group, Haymes Paints, Nufarm, PerkinElmer, PPG Industries, Proctor & Gamble, KPMG, CSIRO, ACCORD, ANSTO, SEMIP, STC, SEMMA and EPA Victoria.

Sector: private industry and government

Sources of Support: $5.9 million (cash and in-kind) from the State Government of Victoria, Monash University and industry partners

1. Purpose of programme/project

The Australian chemicals industry, which underpins 109 of the 111 industries in Australia, produces goods and services essential for food and agriculture, mining, building and construction, medicine and pharmaceuticals, packaging and vehicles. The sector needs new knowledge and skills to ensure long term viability to deliver more efficient/cost-effective-processes, reduce environmental impact and reduce reliance on non-sustainable feed-stocks. Therefore, by working collectively with industry partners, Monash embraced the opportunity to contribute to innovation and solve industry identified challenges in the Plastics and Chemicals Industries Association's (PACIA's) *'Adding Value: Strategic Roadmap'*.

We set out to address the needs through an industry collaboration initiative that aimed to produce a new generation of skilled employees, share knowledge across academia to industry and up-skill current industry personnel to maximise future growth.

The strategic collaboration model we developed with industry has the following goals:

1. Exploit new global market opportunities: implement research and development exploration (products/manufacturing processes with intellectual property) through innovation projects.
2. Drive enhanced workforce skills to remain ahead of challenges.
3. Collaborate to foster (attract, train, retain) skilled professionals in innovation for industry.
4. Share and transfer knowledge for best practice (global perspectives).

The desired outcome of the strategy

Through this $5.9 million initiative for the C&P Innovation Network and Training Program, Monash aims to achieve 'deep' relationships and lasting interactions forming between industry and academia for the Australian chemicals industry. In partnership with PACIA, the collaboration brings together Small-to-Medium Enterprises (SMEs) and Multinationals (Australian and international) into a cooperative framework hub that is geared to enhance productivity for the sector. This is achieved through innovation, education and training of the sector on innovation best-practice (business to business and academia to industry), and

acts as a vehicle for generating leading-edge thinking and commercial Intellectual Property (IP) for global market exploitation.

2. Summary of collaborative approach

The key feature of this initiative is that it facilitates engagement across diverse companies, government, industry associations and the R&D sector. It demonstrates genuine commitment towards common goals of (a) improving innovation best practice in the sector, (b) creating future sustainability for skilled talent, and (c) driving collaboration between the R&D sector and industry for commercialisation (globally).

We have brought together over 20 Chemicals and Plastics partners (multinationals, SMEs and industry associations) as founding members of a Victorian State Government supported Manufacturing Productivity Network in partnership with PACIA, coupled with an industry-innovation focused training program for PhD students working on industry projects (a Graduate Research Interdisciplinary Program). The innovation training is delivered by industry and open to industry partner participation (co-learning).

Pre-existing partnerships

This program builds on and combines Monash University's significant academic and research strengths in Chemistry, Chemical Engineering and Materials Engineering, including previous successes such as the ARC funded Centre for Green Chemistry (2000-2012).

Recent infrastructure investments, particularly the Green Chemical Futures (GCF) building $79.56 million through co-funding from the Federal Government's Education Investment Fund (EIF) awarded in 2010 has been a pivotal catalyst for enabling this industry collaboration at Monash University, coinciding with the completion of the building in 2015.

Furthermore, the research support base is reinforced and complemented by the Victorian Centre for Sustainable Chemical Manufacturing (VCSCM), which is a $24.9 million Victorian State Government co-funded centre established in 2012 to support the SME sector, in consortia partnership with PACIA , Environmental Protection Agency (EPA) Victoria and the CSIRO.

The innovative nature of the engagement strategy

We provide a bespoke framework under which over 20 industry participants (SMEs, multinationals, industry associations and R&D participants) can share knowledge, support skills development for staff and collaborate on similar issues or problems within the sector in Australia. This is underpinned by significant support and input from Monash via an industrial training program and outstanding research capability. This innovative model combines an industrial membership Network with a Training Program, thereby providing genuine opportunities for multiple partnerships through a single collaboration vehicle

encompassing deep relationship building, knowledge exchange, 'multidisciplinary' research and commercial output.[4]

3. Analysis of collaborative approach

The Network has a membership consortium of over 20 industry partners and the Training Program has an initial cohort of up to 20 'elite' PhD scholars, who are screened by both Monash and industry. These PhD scholars are aligned with a company and jointly supervised/mentored on a project that was co-developed by the company. In addition to their cash contribution, members provide training activities, internship opportunities (local and international) and resource the co-developed projects with Monash.

Moreover, the training is further enhanced through member contributions to at least one training initiative per year e.g. workshops/seminars/lectures on business or advanced technical topics, industry field visits, etc. The genuine cross-collaborative nature of these targeted training not only benefits the PhD scholars, but also industry staff members and Monash researchers alike.

However, the most successful element of the collaborative approach has been the deployment of PhD scholars as a catalyst in bringing industry together with Monash, i.e. they are viewed as the future of the industry. As a result, we now have competitors working side-by-side in a dynamic and hybrid-open innovation environment for the 'greater good' of the industry.

The strategic direction of the program is governed by a Board, comprising key industry participants (Vice-Presidents, Directors and R&D Managers), the Lead Scientist of Victoria and Monash stakeholders.

The initiative was officially launched by the Hon Lily D'Ambrosio, Victoria Minister for Industry and the Minister for Energy and Resources. In her opening speech, the Minister welcomed the initiative that sees the best minds in academic research joining forces with government and industry.

The Minister stated that the Australian chemistry industry is the second largest manufacturing sector in Australia and this exciting new initiative will act as a catalyst for new opportunities in global investment, innovation, productivity, job creation and economic growth.

Furthermore, she identified the pioneering nature of this initiative, in that it establishes a model that can be replicated across many industries and is scalable. It is an industry-aligned, structured approach for genuine industry R&D sector collaboration.

[4] Practices of Successful Organisations Applied to Centres of Excellence in New Zealand JD Lawrence, PS Bodger - Management of Innovation and Technology, 2006 IEEE …, 2006

4. Details and analysis of impact

The broader activities within the Green Chemical Futures umbrella are all 'interconnected' and 'complementary' with a focus on adding value to industry through collaborating with Monash. This includes the C&P Innovation Network and Training Program, the VCSCM, the PerkinElmer Flagship Facility, the Axieo Centre for Innovation and many other partnerships currently under development.

Since the announcement of funding in September 2014 by the Victorian Government, the program is full steam ahead. It has two Co-Directors, a dedicated Innovation Manager and a committed Industry Board representing the broad diversity of the sector. The comprehensive Training Program has also commenced and will include activities such as Proctor & Gamble's *'Serial Innovator Program'*, which teaches entrepreneurship and product development (the Proctor & Gamble way), will run through the program for the first time in Australia. Other training areas co-delivered by industry and Monash include intellectual property, commercialisation, project management and sustainable/green chemistry.

Whilst it is too early to predict the final outcomes from the overall collaboration, it is apparent that this initiative is indeed already creating significant industry wide impact for the sector. The Training Program gives industry a role in fostering the next generation of scientists and engineers and strengthens relationships with Monash and its research capabilities. Moreover, many of the participating companies are aiming to build a 'deeper' partnership with Monash. Key examples arising through this program thus far includes the PerkinElmer Flagship Facility at Monash and the Axieo Centre for Innovation at Monash.

The PerkinElmer Flagship Facility is an analytical platform that brings the global capability and technology expertise of PerkinElmer for analytical testing and diagnostics into Monash. It is the first Monash Research Technology Platform that is industry led, adding to over 30 platforms at Monash, many of which are ISO9001 certified and established to serve the needs of the research community and industry. Whilst Australian owned multinational, Axieo has established the Axieo Centre for Innovation, where we have partnered to research and explore opportunities to co-develop innovative solutions for the food, plastics, agriculture and mining sectors, as well as provide industrial training for graduates.

Overall, the innovative design of this initiative brings together industry-academia, engineers-scientists, over 50 researchers, 60 training activities and has 'sparked' at least 20 'new' commercially driven R&D projects and internships. Moreover, it will deliver beneficial outcomes to hundreds of other businesses associated with the Network and paves the way for many more collaborations to follow, similar to PerkinElmer and Axieo.

Other outputs through the broader collaboration have included the hosting of many industry events and opportunities: the PACIA Leaders Forum (40 leaders including Australia's Chief Scientist), ACCORD's Cleaning & Hygiene Conference on sustainable manufacturing (80 industry participants), 13 job application submissions into BASF, the BASF Kids' Lab for 700 6-12 year old children to encourage STEM, several ARC Linkage proposals, a team MBA project and the hosting of multiple executive international delegations to showcase the collaborations. Furthermore, the VCSCM has engaged with over 80 SMEs and conducted

63 projects to-date, worth over $6 million. Of these, 20 projects have been successfully commercialised, generating 15 new products.

Collectively with industry and PACIA, Monash University has a vision for the future that sees the broad collaborations under the Green Chemical Futures and the linkages it creates as driving the innovation edge for the Australian chemicals industry ‘globally’.

Murdoch University — In partnership with Sarepta Therapeutics to develop novel therapies for rare diseases

Developing a novel drug is a challenging task for even the biggest of the pharmaceutical companies. The timelines and costs are enormous in scale. This collaboration between University researchers from Murdoch University and the US Biopharmaceutical Company Sarepta Therapeutics is a great example of effective University-Industry partnership.

Professors Steve Wilton and Sue Fletcher from Murdoch University have extended their collaboration with Sarepta Therapeutics to develop novel genetic therapies for inherited and rare diseases for which limited or no treatment options are available. This collaboration follows on from an existing relationship between the researchers and Sarepta Therapeutics. This collaboration has also extended across two different university settings with Professors Wilton and Fletcher moving from University of Western Australia to Murdoch University in 2013. The lead drug candidate, eteplirsen, being developed by Sarepta Therapeutics is a product of this collaboration and is currently under US FDA review. Eteplirsen is a new genetic therapy for Duchenne Muscular Dystrophy (DMD) patients.

DMD is an inherited disease which affects mainly boys. DMD results in muscle degeneration and premature death. The boys that survive to early adulthood live a severely compromised quality of life as they are generally wheel chair bound by the age of twelve.

The production of the protein dystrophin can be severely impaired in DMD patients. Dystrophin is a protein that provides strength and stability to muscle fibres and protects them from contraction-induced injury. The mutations in the DMD gene cause impaired production of the protein through insertion of stop codons. The exon skipping technology allows the cell machinery to “skip over” the mutated part of the gene message, producing a functional dystrophin.

DMD is one of many thousands of rare diseases. The exon skipping technology can be applied to other rare diseases such as spinal muscular atrophy and adult onset Pompe’s disease. Exon skipping is mediated by “antisense oligomers” that act to obscure regions around a disease causing mutation to alter the gene message and restore functional protein expression. The collaboration provides Sarepta Therapeutics’ proprietary phosphorodiamidate morpholino oligomer (PMO) chemistry that is also used for eteplirsen and other oligomers in the DMD patient studies.

The success of the collaboration in the DMD field has resulted in Sarepta working with Murdoch University to develop therapies for adult onset Pompe’s Disease, and a master four year collaboration agreement has been signed to explore the potential of the technology in other diseases with limited or no therapies available. There are a number of key factors that have contributed to the success of the collaboration. In summary these factors are listed below.

World class science

The research team has pioneered in the field of developing exon skipping as a therapy for DMD. They were the first to report and demonstrate exon skipping in the mouse model of DMD and published the only panel of exon skipping oligomers for the entire *DMD* gene.

Common vision

Both the two key researchers and Sarepta Therapeutics have shared a common vision to develop therapies for rare diseases. Professors Wilton and Fletcher reached out to Sarepta Therapeutics (previously AVI Biopharma), showing proof of concept, to initiate the collaboration and have worked with the company to develop the therapy for DMD to the clinic.

Effective project management

Projects are initiated by having a clear research plan with defined objectives and deliverables.

Communication and monitoring

The scientists and the Sarepta team have regular meeting and conference calls to keep each other updated on the progress of the projects.

Multidisciplinary teams

Scientists at Sarepta Therapeutics and Murdoch have worked collaboratively in progressing the commercialisation of the DMD technology. A research project on Pompe's disease has also been very collaborative, with both parties contributing scientific knowhow. The exchanging of knowledge and data has been reciprocal between Murdoch and Sarepta. A number of patents have been filed that have inventors from both Murdoch and Sarepta.

Trust and commitment

Sarepta has remained committed to supporting the research of Professors Wilton and Fletcher.

The relationship has been built on trust with the collaboration extending to beyond eight years. Murdoch University has recently signed a four-year agreement with Sarepta Therapeutics, with the purpose of using Sarepta's PMO technology in researching and developing treatment solutions for other rare genetic diseases where there is a significant unmet medical need.

Mutual understanding of drivers

Murdoch appreciates Sarepta's commercial drivers and sensitivities in terms of Intellectual Property protection strategy, management and delaying publications.

Sarepta understands Murdoch's drivers through allowing the use of new intellectual property developed for education, publication, and research purposes.

People and managing relationships

Both Professors Wilton and Fletcher have been instrumental in driving and managing the collaboration with Sarepta Therapeutics across two different universities.

Queensland University of Technology — Brisbane Airport Corporation

Partners or end-users: Brisbane Airport Corporation (BAC), other Australian airports, aviation industry

Sector: Private Industry

Sources of Support: Direct industry support (financial), ARC (various schemes), Queensland State Government

The problem to be solved — airport productivity (why airports need innovation)

The Brisbane Airport first made headlines when Sir Charles Kingsford Smith and crew landed the Southern Cross at the end of the first Pacific Ocean crossing by flight to a crowd of around 25 000 spectators. More recently, Brisbane Airport Corporation (BAC) was recognised at the Australian Institute of Project Management (AIPM) Awards and the Australian Airports Association (AAA) Awards, winning the AIPM Defence/Aerospace Project Management Category for its facilitation of world leaders through Brisbane Airport during the G20 Summit, and the AAA Capital City Airport of the Year Award.

As is the case with many Australian and international airports, Brisbane has had to increase throughput productivity over a period when the city has encroached and surrounded the facility. Modern air travellers demand easy access to terminals, car parks and increasingly safe and frequent departures and arrivals. At the same time, residents demand that vehicle traffic and aircraft noise are kept at bay within the extensive air shed and traffic footprint of the airport. In addition, global airlines have choices when it comes to which airports they hold contracts with and airports therefore need to maintain pace with the expectations of the global airline industry. In the late 1990s, Brisbane airport recognised that in order to maintain pace with both international and local expectations, substantial innovation across a range of services was going to be required.

The innovation partnership

The long-standing innovation partnership between the BAC and Queensland University of Technology (QUT) is described by the BAC corporate website (http://www.bne.com.au/corporate/about-us/sustainability/bac-qut-reach-skies) as follows:

‘This powerful combination continues to set global benchmarks, contributes to achieving best practice management and operation of Brisbane Airport, and also contributes to Australia’s reputation as a centre of excellence in aviation and environmental management.’

QUT's partnership with BAC commenced following a meeting between QUT and BAC in 1999. An immediate outcome of this meeting was the formalisation of the innovation partnership in 2000 and the development of a successful application for an Australian Research Council linkage grant.

Since 2000 the partnership has encompassed a wide range of projects that led to collaboration between all of BAC's departments and a large number of QUT researchers from disciplines ranging from engineering to psychology and design (see http://www.bne.com.au/corporate/about-us/sustainability/bac-qut-reach-skies).

The QUT-BAC partnership has commissioned and delivered 56 projects of a total value in excess of $11 million. Over the last five years alone, more than 80 journal articles, book chapters and conference publications have been published. To facilitate collaboration, QUT and BAC established the position of a Chair in Airport Innovation at QUT. Most collaborative projects have been co-ordinated and executed under the oversight of the chair and a steering committee that included members of the airport executive. These projects ranged from commercial research and consultancies to research grants and student projects. A number of projects were supported by funding from the Australian Research Council (ARC) and partners from industry and State Government. The partnership has also benefited QUT's student cohort with both undergraduate and graduate students being involved in collaborative projects and BAC hosting numerous undergraduate students for work experience. An example of the outcomes such projects can deliver is the development of a digital departure card by QUT students and staff in close collaboration with BAC colleagues (https://www.qut.edu.au/science-engineering/about/news/news?news-id=86942).

BAC also houses the QUT aerospace automation research and development facility, the Australian Research Centre for Aerospace Automation, at its DaVinci Precinct. The facility includes an aircraft simulation and testing laboratory, indoor flying area, mobile operations centre and customised unmanned aircraft.

A particular focus of the partnership over recent years has been to identify potential productivity improvements through digital technology. BAC recognised the potential impact of digital disruption along with the opportunity for better throughput and customer experience through leveraging social media platforms to empower the customer and enable the sharing economy in the airport ecosystem.

Direct research impacts

Brisbane Airport is a progressive, multiple award winning international facility that has increased throughput and productivity in a manner compliant and consistent with consumer and regulator safety and performance expectations.

This has been achieved through innovation in planning, operations and management of the facility. The innovation partnership has developed and delivered multiple key projects in all of these spheres of the BAC business.

The impact of this research is demonstrated by one of the flagship projects — the Airports of the Future Project.

This project, the largest in this collaboration to date, engaged 21 research partners Australia-wide and internationally, including airports, airport and airline service providers and government agencies. It aimed to improve the safety, security, efficiency and passenger

experience within Australian airports, and BAC in particular, by developing an integrated and adaptive multi-disciplinary approach for the design, management and operation of airports.

The key disciplines involved in this research included: Business Process Management, Human Systems, Intelligent Surveillance and Business Continuity Planning. The scale and active participation by key BAC executives provides a compelling demonstration of commitment from industry towards this project. It also emphasised the importance and necessity of undertaking research to address the challenges confronted by today's airports.

The research team developed 37 recommendations from the project. Of these, 28 were put into practice at Brisbane International and Domestic Airport Terminals. Six recommendations had immediate and significant impact on the design and operation of the security screening points and these have led to significant time savings at the security screening points at Brisbane Airport.

The implementation of the QUT recommendations from the project have directly improved productivity and reduced the cost of mandated security. This cutting-edge study was the first to bring together the Australian Federal Police, Australian Customs and Border Protection Service, Department of Infrastructure and Transport, and airports on a single research project in Australia. The collective work is therefore seen as setting a benchmark for the operation and design of security screening points in Australia. This work has also been endorsed by the International Air Transportation Association, demonstrating it as an international benchmark for approaching traditional engineering problems faced by the industry.

Other significant projects include:

- A series of projects to achieve sustainable water management. These have led to:
    - ongoing annual savings of around $2.4 million;
    - reduction in potable water consumption of around 70 per cent;
    - introduction of high-quality recycled wastewater cooling towers.
- Development of a cost-effective grassland and weed management strategy resulting in savings in maintenance costs.
- A long-term strategic approach for energy use at the airport.
- The development of an intelligent surveillance system and early warning support for monitoring human traffic in airport buildings.
- Development of marketing strategies for BAC and the 'southern Queensland' trade brand.
- Strategies and approaches for organisational knowledge management.
- Streamlined air quality assessment approaches.

These projects have drawn expertise from across QUT in order to address the complex, cross disciplinary issues involved.

Key success factors

The key success factors in this long-standing collaboration included:

- QUT researchers being able to deeply understand the needs and aspirations of BAC.
- QUT researchers being able to provide the required capabilities and capacities to address the identified needs, either through in-house research capability or through effective collaborations.
- Sustained track record of timely delivery of relevant outcomes.
- Effective governance and relationship management arrangements being established and maintained.

RMIT University — ANCA Pty Ltd Diamond Tool Manufacture Project

Partners/end-users: ANCA Pty Limited (Australia), Precorp (United States)

Sector: Private sector

Sources of Ssupport: RMIT University, ANCA Pty Limited, Advanced Manufacturing Cooperative Research Centre

Purpose:

Demand from the aerospace and automotive industries for more efficient and light-weight products is driving the development of new and exotic materials. As these materials become more advanced, they are challenging traditional manufacturing methods and driving advances in the design specifications of the tools used to interact with these materials.

Advanced composite materials, such as alloys and non-metals are increasingly being used in the design and manufacture of aircraft, due to their lighter weight and greater durability, when compared more traditional aircraft materials. For example, the Boeing 787 Dreamliner is the first major airliner to use advanced composites as the primary material in the airframe construction, representing over 50 per cent, by weight. By using new and lighter materials, the Dreamliner is designed to be 20 per cent more fuel efficient, quieter to operate and less expensive to maintain.

As a result of the rapid adoption of new materials, manufacturing processes have needed to change, including the tools used to drill or cut the materials. As diamond is the hardest naturally occurring material, there has been an increase in demand for Polycrystalline Diamond (PCD) cutting tools because of their superior cutting and wear characteristics compared to conventional tools. To manufacture and sharpen PCD tools requires a grinding technology adapted to the mass removal of hard materials that would be very difficult to machine using traditional methods. The collaboration between RMIT University and ANCA Pty Ltd aimed to develop a working prototype of an Electric Discharge Grinding (‘EDGe’) machine capable of fast removal of PCD materials, and to ensure commercial viability in its application to rapid grinding and re-grinding of PCD. Instead of mechanical grinding, the EDGe machine fires electric sparks at the material and controls and monitors the energy levels of every spark to optimise the surface finish. The project involved the development and testing of new EDGe technology incorporated into a traditional CNC (computer numerical control) grinding machine to manufacture and resharpen quality PCD tools.

Summary of Collaboration:

The Diamond Tool Manufacture Project was an academia-industry project carried out under the auspices of the Advanced Manufacturing Cooperative Research Centre (AMCRC), between 2010 and 2013. ANCA Pty Ltd is a leading supplier of automatic manufacturing equipment used in the production and reconditioning of machine cutting tools and is listed in the top three suppliers of its type globally. Due to this track record, ANCA was already

associated with the AMCRC, which led, in turn, to the establishment of the Diamond Tool Manufacture Project.

The project schedule was designed around five key competencies, which were articulated at the outset. Three of the five competencies form the basis of ANCA's core engineering knowledge and experience. Market analysis revealed that of ANCA's four main global competitors, only one had significantly addressed all five competencies. RMIT was able to bring the engineering skills and capabilities required to deliver on the two missing competencies. Thus, the partnership was perfectly complementary, by strengthening ANCA's industrial capabilities while simultaneously enhancing RMIT's research capabilities, including through the provision of research opportunities for both experienced and early career engineering researchers.

Testing of the EDGe machine occurred at Precorp, a leading United States manufacturer of PCD cutting tools and a key supplier to companies such as Boeing. The success of the project was therefore the result of extensive collaboration among stakeholders covering all aspects of a complex system engineering cycle. At the concept development phase, Precorp was essential in identifying and defining the capability of the system in an industrial environment. Precorp provided the project team with existing mechanically ground PCD drills for baseline assessment of quality, marketing and sales information, which eliminated many risks associated with the end-user acceptance of the research outcome.

The relationship with Precorp extended into the system verification phase. The collaboration with Precorp enabled the EDGe prototype to be validated in a real world setting, which saw it progress through a rapid development cycle and enter the market only three years after project initiation.

Additional expertise in power generator systems had to be sourced during the system design phase. As part of the literature review, researchers identified new collaborators and leveraged existing linkages to invite colleagues from China and Germany to assist the project team with expertise in electric discharge machining. Working in parallel, ANCA's Taiwan branch purchased new electric pulse generators to build trial EDGe machines. In sum, these knowledge acquisition activities accelerated the process of clarifying the necessary research direction.

RMIT research and ANCA expertise coalesced during the system development phase to further accelerate the project. RMIT contributed research in correlating materials properties to the process parameters on the surface finish of the PCD tools, drill bit microstructure analysis, and residual stress assessment. These investigations were integrated with ANCA's machine engineering and motion control expertise to enable the project to quickly move to implementation. The EDGe machine moved from concept to functional product within the timeframe of the project.

Although the project is now complete, the RMIT-ANCA relationship continues. The ANCA Project Champion was appointed an Adjunct Professor and is a member of the Program Advisory Committee at RMIT's School of Aerospace, Mechanical and Manufacturing Engineering.

Analysis of Collaborative Approach:

RMIT made available the use of its Advanced Manufacturing Precinct and other specialist facilities, ANCA made available its existing manufacturing plant, and the AMCRC sponsored four of the six PhD candidates involved in the project. All three parties made financial contributions to the project, with, RMIT, ANCA and the AMCRC each contributing one-third of the budget. A large part of RMIT's contribution consisted of in-kind support to cover laboratory usage and research instrumentation, salaries of senior researchers, and academic support. The stipends for research fellows and PhD candidates were covered by the AMCRC. Ownership of intellectual property developed over the course of the project was vested with ANCA, while providing RMIT with usage rights beyond the project completion.

The collaborative approach helped ANCA achieve product and process developments in a three year period that would otherwise have not been feasible under a business-as-usual approach to research and development. RMIT's research capability contributed to several breakthroughs during the project.

From RMIT's perspective, the collaboration with ANCA provided a unique opportunity for six PhD candidates to work closely with industry. The candidates spent over 30 per cent of their project time at ANCA's facilities and attended all project meetings. A top performing PhD candidate travelled to Precorp in the United States to assist with the validation trials. All PhD candidates benefitted from gaining experience in quality systems and project management practices in a leading manufacturing environment.

The most successful element of the collaborative approach was the close working relationship between the RMIT and ANCA teams. The two teams participated in joint bi-weekly meetings at ANCA's Melbourne premises, which saw team members report on project activities and provided a forum for ongoing review and refinement of the research direction. In general, project participants were motivated by the structured intensity of the collaborative space, leading to the rapid incubation of new ideas and approaches. Particularly in the first part of the project, the team faced stumbling blocks due to the steep learning curve associated with the science of electric discharge machining. A key lesson was recognising the importance of open communication between teams and fostering an environment where findings were shared among team members as quickly and openly as possible.

Analysis of impact:

The EDGe machine was officially launched at the leading international trade show for manufacturing, EMO, in Hannover in September 2013. Precorp has since taken delivery of six EDGe machines, which are being used for aerospace and other manufacturing purposes.

The innovation is the new patented electric discharge control system that makes the EDGe more advanced that the competitors. The new machine has proven its capability by having significant impact in the global marketplace, by increasing the productivity of manufacturing in carbon fibre composite materials; increasing the time between drill replacements; and reducing the reject rates of carbon fibre components. As an advanced manufacturing

technology, the EDGe machine has lifted the profile of ANCA and Australia in the highly competitive and globalised manufacturing environment.

The technology behind the innovation has received academic recognition. To date, the project team members have published individually and jointly one patent, one book, one book chapter, 19 journal papers, and delivered 11 presentations at international conferences. In November 2013, the project team won the 'Best Paper Award' at the 2013 International Conference on Control, Automation and Information Sciences, for their paper, 'Gap Width Control in Electrical Discharge Machining Using Type-2 Fuzzy Controllers.' In May, 2014, the project team won one of the five CRC Awards for Excellence in Innovation.

The EDGe machine is having ongoing impact in improving the productivity and reliability of machining composite materials and is expected to become increasingly relevant as the manufacturing sector continues to deploy carbon fibre composites in new products and processes.

Southern Cross University — Ecofibre Industry Operations

Partners or end-users: Ecofibre Industry Operations (initially)

Sector: Private industry

Sources of Support: Direct support from Ecofibre for 1x PhD student stipend; Direct support from Ecofibre for 2x Honours students (top-up scholarships); Researcher in Business scheme (2012/13); Bi-partite investment with another company; JRE Cadetship

Purpose of programme/project

What was the problem or issue being addressed?

- To establish an ongoing R&D program for industrial hemp
- To characterise a unique world collection of hemp (Cannabis) germplasm
- To extend the scope of current R&D for industrial hemp within Australia

Was there a particular solution to be achieved?

- Initially to identify plant lines suitable for deployment as protected varieties – securing Plant Breeders Rights
- Collate information on characterisation of plant genetic resource collection
- Characterise specific chemistry of different plant lines (cannabinoid composition)

Summary of collaborative approach

What was the nature of the partnership/collaboration?

- Partnership in establishing unique pollen-secure plant growth facilities (owned and developed by Ecofibre) at Southern Cross University
- SCU to manage regeneration and characterisation of Ecofibre genetic resource collection

Was there a pre-existing partnership? How long has it been in effect?

- Previously there had been 2002 through 2008, however this had lapsed. This partnership re-established in 2012.

What were the mechanisms employed to implement and manage the collaborative processes?

- Establishment of MOU, then a formal Research Partnership Agreement between Ecofibre and SCU.
- Enrolling Ecofibre employee in postgraduate program
- Agreeing on short, medium and long-term goals
- SCU recruiting Honours project candidates

- Many bilateral meetings and with third parties
- Applying for third party external funding and collaboratively approaching third parties (academic, industry, state govts) for wider partnerships

Analysis of collaborative approach

What were the contributions of each party? Were they appropriate and effective?

Ecofibre

- Plant materials (seed collection); Growth chambers
- Body of (non-systematic but unique) extensive background knowledge and many contacts
- Enthusiasm, flexibility and persistence
- Funds, encouragement
- Legislative authorisations
- Contributions to collaborative funding proposals

SCU

- Background knowledge
- Unique combination of expertise and facilities for plant growth, genetic analysis, chemical analysis
- Legislative authorisations
- Covering extensive overheads in terms of regulatory compliance
- Contributions to collaborative funding proposals

What specific steps or activities were taken to support/achieve mutual interests and benefits, due to the different organisational drivers?

- Ongoing discussion and consolation
- Shared activities in working on plant materials

What was most successful element of the collaborative approach?

- Applying background knowledge of genetics and analytical chemistry (from SCU) to specific issues encountered by Ecofibre
- Ecofibre providing SCU with extensive exposure to wider context of industrial hemp (and subsequently to medicinal cannabinoid) research and development.
- SCU gaining access to plant materials not otherwise available

What lessons were learnt for future/ongoing collaboration?

- Define scope carefully and revisit frequently
- Manage expectations of cost of R&D steps
- Ensure full costs and risk analysis with respect to regulatory compliance are assessed up front

Details and analysis of impact

How well did the programme/project achieve its objectives?

- It is ongoing, but has met valuable milestones for each party

What has been the impact of the programme/project (social, economic, commercial, community and/or other impacts)?

- The outputs are being commercialised in N. America, Australia and elsewhere
- SCU has entered into a research field of very topical relevance and is seen as source of information in the field
- The consequences for additional social impact may be seen in next few years in the side-story of medicinal cannabinoids, where the experience and knowledge gained focused on industrial hemp is readily transferable. The investment by Ecofibre in this area (genetics related to cannabinoid chemical composition) is prescient.

How do or did you measure/evaluate the programme's impact? What was the time frame?

- We assess progress and tangible outputs
- Time-frame has been a rolling window, but defined by a series of specific short projects

Is there likely to be on-going impact?

- Yes, we are increasingly being approached by third parties (industrial, state governments) for information and collaboration

Have there been any evaluations and/or follow up studies of the programme/project?

- Internally yes
- Externally yes – of Researcher in Business co-investment
- Follow-ups are ongoing

Is there any specific data or other evidence of academic or other impact (e.g. citations, patents, start-ups, ongoing or long-term collaboration arising from the programme/project)?

- Plant Breeders Rights for Ecofibre
- R&D funds being sought from venture capitalists by Ecofibre to benefit SCU
- SCU academic outputs – publications anticipated to be widely cited due to relevance and timeliness

How did the collaborative approach contribute to the impact?

- Essential. Would not have occurred otherwise.

Southern Cross University — Feros Care

Partners or end-users: Feros Care aged care provider

Sources of Support: Commonwealth Department of Industry 'Researcher in Business' grant with matched funding from Feros Care and in-kind support from Southern Cross University

What was the problem or issue being addressed?

The aim of this project is to work with Feros Care to develop 'user centred design' protocols to determine the effectiveness, safety, risks, potential benefits, and specific service parameters of applying new types of technology designed to help keep older people independent in their own home. For example, there are an increasing number of GPS enabled devices designed to monitor people with dementia to reduce their risk of wondering into a dangerous situation. However, there are no published studies of the use, evaluation or implementation of these devices in Australia.

This study aimed to examine the attributes of the new technologies, in the context in which they are to be applied, to determine their usability. Other technologies to be evaluated included environmental sensors (smoke, gas and flood sensors); automatic night light with bed sensor (light turns on when the person gets out of bed); sensor mats, pagers and pillow shakers (alerts carer to senior's wondering through pager or pillow shaker); lively homecare solution which monitors medication use, fridge use, outings and activity; inactivity sensors; touchscreen technology for brain games, video calls, photos and reminiscence therapy.

The project ran from October 2014 – October 2015.

Summary of collaborative approach

History of the relationship

SCU and Feros Care have a long-standing relationship, in – part due to our geographic proximity, but also due to relationships formed by staff from both organisations around specific aspects of aged care delivery. For example, Professor Colleen Cartwright (Professor of Age Care Services) was a board member of Feros Care and also provided advice on advanced care directives. Professor Susan Nancarrow (health services researcher) led the evaluation of Commonwealth funded National Broadband Network pilot delivered by Feros Care in Northern New South Wales (2013 – 2014).

What were the mechanisms employed to implement and manage the collaborative processes?

Southern Cross University employed a researcher using the joint funding. The researcher was placed with Feros Care for a 12 month period to achieve the project aims, and jointly supervised by a member of the Feros Care technology team and a research professor at Southern Cross University.

What was the nature of the partnership/collaboration?

The collaboration was driven, in part by the terms of the Researcher in Business funding grant, and specifically designed to help achieve the business goals of Feros Care in establishing decision rules and business models to test and implement new technologies.

Analysis of collaborative approach

What were the contributions of each party? Were they appropriate and effective?

Feros Care provided funding, a governance framework in which the researcher operated, access to all tools and technology required to deliver the task.

SCU provided supervision, support and academic guidance for the researcher; ethics approval; structures to support research governance of the project; guidance around academic publications and report writing; legal support, including a confidentiality agreement and collaboration agreement.

Department of Industry: provided 50 per cent funding of the researcher's time.

What specific steps or activities were taken to support/achieve mutual interests and benefits, due to the different organisational drivers?

A confidentiality agreement and collaboration agreement were signed by both parties to protect the IP of Feros Care and clarify the IP arrangements arising from the project.

What was most successful element of the collaborative approach?

Both organisations benefitted from having a staff member acting as a 'boundary spanner'. SCU had the benefit of regular insight into a market leading aged care provider testing and applying telehealth solutions for their residents.

Feros Care benefitted from access to a supernumerary staff member dedicated to establishing a robust technology testing and evaluation framework, with in-kind support from the University.

What lessons were learnt for future/ongoing collaboration?

Personal relationships between individuals within organisations are key to developing and sustaining collaborative partnerships, these need to be based on trust, integrity, and delivery of high quality outputs.

We attempted to 'piggy-back' another project onto this technology project. However, the student project was poorly conceived, the student had a limited understanding of the commercial environment and context in which the tool was to be introduced which had two implications (a) there was a lack of trust between the supervisor/student and Feros Care (the researchers were concerned about losing their project IP) and (b) the quality of a survey tool was not appropriate for distribution in a commercial context. The result was that the

survey tool was not used by Feros Care and some damage control was needed to maintain the relationship, which wasted the time of some very busy people.

Details and analysis of impact

How well did the programme/project achieve its objectives?

The program was successful in achieving its objectives. The goals of the program were to establish robust and ethical protocols for testing technology which could be adopted by the organisation and used on an ongoing basis. This was achieved, and several telehealth technologies have been tested as part of the approach. The impact of the program was to develop and embed a sustainable telehealth technology testing framework.

What has been the impact of the programme/project (social, economic, commercial, community and/or other impacts)?

As a result of the program, Feros Care has adopted new telehealth technologies. For example, the first technology to be tested was a GPS watch which can be worn by people with dementia to stop them wondering outside a defined area. This technology has been adopted in one of the Feros Care aged care facilities for residents with a known history of wondering. This technology helps keep residents safe, while maintaining an unrestrictive perimeter around the aged care facility (i.e. there are no gates).

How do or did you measure/evaluate the programme's impact? What was the time frame?

The program was largely evaluated against the initial funding goals that were to be achieved within the funding time frame of 12 months.

Is there likely to be on-going impact?

The researcher employed under the Researcher In Business grant has now been offered a six month contract with Feros Care (commencing October 2015),which will help to sustain the approach in practice.

The project was established in a way that meant that established protocols for the testing and implementation of any new telehealth technology. These protocols were designed be used by any member of staff involved in new technology testing and application within Feros Care.

Have there been any evaluations and/or follow up studies of the programme/project?

The whole program involved an ongoing evaluation of the applied use of telehealth technologies within an aged care setting. The evaluation was applied using a modified of logic decision approach, alongside business principles to determine specific aspects such as the reliability and validity of the tool, as well as the commercial applicability.

A formal evaluation report is currently being prepared.

Is there any specific data or other evidence of academic or other impact (e.g. citations, patents, start-ups, ongoing or long-term collaboration arising from the programme/project)?

Outputs are being prepared for publication in peer reviewed journal articles. The project was only completed this week.

Feros Care recently held a technology Boot Camp, which was an exposé of all of their telehealth technology, their approaches to development, implementation and testing. It was open to (and well attended by) other aged care provider industry members as a way to showcase the technology they have developed and cascade the learning around technology adoption to the aged care industry.

How did the collaborative approach contribute to the impact?

The collaboration brought together an industry partner and academic expertise to achieve the goals of testing technology for end-use in a commercial context. The industry partner provided a unique and innovative environment to access new technology alongside an older population. The university partner provided academic rigour and research governance to ensure that the technology was tested using sound evaluation principles, without posing risk to the target population, and reported in a way that allows translation of the principles into other settings and for other providers.

The Australian National University — Sirtex

Partners or end-users: Sirtex

Sector: Private Industry

Sources of Support: ARC Linkage Project, Research collaboration agreement funds (directly from research partner)

Purpose of programme/project

Research into localised cancer treatment is the focus of a long-standing cooperation between Australian-based global life-sciences business Sirtex and The Australian National University, and may lead to a new generation of cancer therapies.

The relationship between ANU and Sirtex developed after their first meeting in 2006, via a significant alignment of interests primarily around cancer treatment technology. In particular, Carbon-Cage Nanotechnology (CCN) developed from ANU research targeting the detection and treatment of blood clots was recognised for applications in carrying cancer-target agents to cancerous cells.

The technology developed with this collaboration has subsequently come a long way, with the intention of progressing to the clinic. A number of projects exploring the use of the technology in unmet areas of medical need, such as lung cancer and ovarian cancer are currently underway.

Summary of collaborative approach

As the catalyst for collaboration, Sirtex had developed an approved isotope therapy for patients with liver tumours, and had demonstrated success in improving patient survival. Sirtex approached ANU for solutions to specific issues in assessing patients for treatment using nanoparticle technology, and advanced image-processing software to assist doctors. The solutions proposed leveraged ANU research into nanoparticulates with medical applications. This research was supported through an Australian Research Council Linkage Project grant.

While the initial application was in screening patients by locating blood clots, Sirtex and ANU quickly saw a greater potential. Carbon-cage nanoparticles are sub-micron size particles of graphitic carbon that encapsulate a metallic core, that carry a radioactive material while the outer carbon shell is chemically inert. The materials could be developed to possess properties to better evade detection by the immune system, target specific cancers and deliver radiation locally.

As the Linkage Project progressed, Sirtex and ANU identified a number of areas of mutual interest, leading to a formalised five-year collaborative research agreement setting out a list of proposed project topics progressing the research, particularly the use of radio-labelled nanoparticle FibrinLite. FibrinLite is a patent held by ANU, based on a history of research and development into nano- carbon composites with clinical application, such as Technegas

(1984). The five-year agreement has subsequently been extended, and further research supported through investment in a professorial Sirtex Chair.

The collaboration has provided a development path involving all parties in the full journey from discovery through to clinical application. Sirtex employed intellectual property developed through the collaboration to explore the clinical potential through a Master Research Collaboration Agreement with the National Cancer Centre of Singapore (NCCS). ANU has been able to access expertise to develop clinical applications for a new generation of cancer therapies, commencing with ovarian cancer.

The collaboration has also opened relationships beyond Sirtex's cancer treatment priorities, bringing benefits to both partners. For example, the partnership allows ANU access to commercial services such as Douglass Hanly Moir pathology and Gribbles Veterinary Pathology that are often required in early developmental work.

Analysis of collaborative approach

The relationship strength is reflected by the escalation of Sirtex's investment in the research. The collaboration began in 2006, with a continuous sponsored research relationship in place since 2008. As the relationship strengthened, a professorial chair was donated in 2013, marking a further three years in research funding, licence fees and donated equipment. The Chair and research collaboration have now been extended with a formal arrangement until 2018, showing a strong strategic alignment between Sirtex and ANU. This mutually beneficial relationship has enabled ANU and Sirtex researchers to garner strengths of both organisations: the University's world class research facilities and Sirtex's commercial expertise and market position.

The key ANU researchers, Professor Ross Stephens and Professor Tim Senden, lead ANU teams incorporating multidisciplinary expertise, bringing together researchers from the Biomedical Radiochemistry Laboratory, part of the ANU Research School of Physics and Engineering, and those from the ANU John Curtin School of Medical Research.

The Sirtex team involved in the collaboration with ANU is also multidisciplinary and from all levels, including the company's Chief Executive Officer. Most heavily involved in the collaboration is Sirtex's Research and Development Department. The team consists of seven staff all with scientific, medical or engineering backgrounds and all with substantial past experience in a research environment. Having this expertise within Sirtex has enabled full engagement in the process of articulating the research problems and understanding solutions.

Meetings are technically focused, but with engagement from the ANU Technology Transfer Office to contribute to discussion of IP strategy in the context of the emerging science. This engagement ensures ANU and Sirtex can readily discuss agreements of relevance to the collaboration, including engagement of consultants and outsourcing of components of development. As a result of these meetings, Sirtex have engagement not only with the scientific team, but also with the Technical Transfer Office, Legal team and have developed productive dialogue with the senior leadership of the University. It is this senior engagement and dialogue that was critical in expanding the association from its initial focus to the

creation of a Chair, engagement in wider collaborative research and the initiation of new programs.

Since the two partners came together, the research that has been produced speaks volumes about the strength of the relationship. Key to the success of the collaboration is its flexible and dynamic nature, where ANU researchers have been given freedom to pursue new leads in materials or methodologies as appropriate. Sirtex has recognised the value of publication and exposure of commercially valuable R&D to peer review, while ANU highly values the ability and commitment of Sirtex to progress emerging technologies to market.

Details and analysis of impact

To date, the Sirtex-ANU collaboration has resulted in five ANU patent applications and three major scientific publications. The collaborations over the years have allowed ANU to also transform carbon-cage nanoparticles into a very useful and unique research tool, with high potential for cancer and non-cancerous diseases.

For example, the Sirtex investment in this technology has enabled further research into use of FibrinLite as a cheaper and safer alternative to the materials currently extensively used as part of scanning for lung circulation deficits caused by blood clots (pulmonary embolism).

Pre-Clinical trial projects are now in place to develop carbon-cage nanoparticle IP into treatments of human cancers, including advanced ovarian cancer. It is anticipated that this long-standing relationship will continue to provide the leading edge from basic research into new nanoparticles, through development phases with a view to new and better clinical cancer and non-cancer treatments for the future.

The Australian National University — Maximum Economic Yield in Commonwealth Fisheries

Partners or end-users: Australian Fisheries Management Authority, Commonwealth Government of Australia, CSIRO, Northern Prawn Fishery

Sector: Government

Sources of Support: Fisheries Research and Development Corporation and ARC

Purpose of programme

The 'Tragedy of the Commons' and overfishing is a global problem. Its impact goes well beyond displaced fishers, impoverished communities and diminished catches. It reduces the fish protein unavailable to hundreds of millions of people and has degraded countless marine habitats. While fish farming has helped to replace declines in wild caught fish (managed or illegal), unreported and unregulated fishing means that less fish will be caught at sea in 2015 than in 2000.

In richer countries, the standard response of 'too many boats chasing too few fish' has been to impose controls and to limit the number of vessels or fishing gear that can be used. Unfortunately, even if rules are observed to the letter, fishers have proven more able than regulators to legally substitute from regulated to unregulated inputs. The result: fishing effort continues to rise, fishers' incomes decline, and fish stocks become even more vulnerable to economic overfishing. In poorer countries, a lack of funds or capacity to manage and monitor fishing and conflicts between inshore fishers and offshore, industrial-scale fishers have devastated many fishing communities and the marine resources on which they depend.

Without a change in fishing practices more of the world's fisheries will be vulnerable to decline or collapse. Importantly, the services from the marine estate on which so many people depend will also decline.

Australian National University professors Tom Kompas and Quentin Grafton, separately and jointly, have been finding solutions to fisheries problems for more than two decades. Quentin's work about how to apply individual catch shares, especially how to increase return to fishers while reducing overfishing, is world leading, and implemented in Australia.

Tom was instrumental in incorporating the concept of maximum economic yield as a key objective into the Australian Commonwealth Fisheries legislation, a world first. His economic analysis of one of Australia's most important fisheries, the Northern Prawn Fishery, was pivotal in improving its management. His underlying analysis in this fishery was recognised with the most valuable research award given by the Australian Department of Agriculture, Fisheries and Forestry. Tom's work with Australia's Resource Assessment Groups that are responsible for deciding how much fish should be caught by species, and also fishery Management Advisory Groups, was instrumental in transforming Australian fisheries management for the better. For this work, with collaborators, in particular for the collaborative work on the Australian Northern Prawn Fishery, he was awarded the CSIRO

Gold Model, one of the most prestigious Australian government awards for scientific research and discovery.

Jointly, Tom and Quentin have made two world-leading policy contributions. They were the first to show how, even with slow-growing fish species, adopting a lower harvest level can generate a 'win-win' in terms of higher incomes for fishers and larger fish stocks. Their insights on 'win-win' solutions in fisheries have been adopted in Australia, the European Union, among other places. They were also pioneers in the ecological-environmental analysis of marine protected areas and have been global leaders in showing how to calculate the optimal size of 'no take' areas for fish populations, and how to promote resilience in the marine estate. Both of these concepts have been implemented in Australia.

In sum, the tragedy of the commons remains an all too common global problem. Careful economic analysis and continuous engagement with managers and decision makers has made a difference in increasing fishing incomes and the sustainability of fish stocks in multiple countries.

Summary of collaborative approach

The success in the Northern Prawn Fishery was a collaborative effort between: the CSIRO, the Australian Fisheries Management Authority, the ANU Australian Centre for Biosecurity and Environmental Economics, and the Northern Prawn Fisheries Industry Association. This involves detailed and ongoing collaboration on research and implementation of the analysis, through the Northern Prawn Fishery Resource Assessment Group (RAG) and the Management Committee for Government and the fishery. On this project the arrangement was been in place and relevant since 2003 when Tom Kompas first joined the RAG. This cooperative management structure is unique — combining science, industry, the university sector and government to help ensure both profitable and sustainable outcomes for the fishery.

Details and analysis of impact

Along with publications in Science and the Proceedings of the National Academy of Sciences, among other journals, and scores of government reports, the project generated three essential outcomes.

First, the project was the first to bring substantial economic analysis to fisheries management in Australia — augmenting the science and biology of fish stocks and fishing. This was an important innovation since fishing behaviour is largely driven by economic considerations in Australia. Second, it established and new target for fisheries management, Maximum Economic Yield (MEY), generating a 'win-win' in terms of higher incomes for fishers and larger fish stocks to satisfy conservationist goals. That target is now an essential part of Commonwealth Law in terms of fisheries management. This work literally changed the law in this regard. Finally, the implementation of MEY in the Northern Prawn Fishery increased profits substantially and returned stock sizes back to levels even larger than traditional Maximum Sustainable Yield values, a great win not only for sustainability but also for conservation.

The citation for the Northern Prawn Fishery Bioeconomic Project Team (Cathy Dichmont, Tom Kompas, Andre Punt, Ray Deng, Nhu Che and Sean Pascoe) that received the CSIRO Medal for Research Achievement (awarded in 2009) reads: *For the development of a combined biological and economic model to guide the management of Australia's Northern Prawn Fishery in a way that ensures industry profitability and a vigorous fishery recourse. The approach was won international acclaim as a global paragon of fisheries management.*

Publications (with impact factors) that stem directly from this work are below:

- R. Quentin Grafton, Tom Kompas, Nhu Che, Long Chu and Ray Hilborn, (2012), 'BMEY as a Fisheries Management Target', *Fish and Fisheries*, 13, 303-312. [Impact Factor: 6.43] (16 citations).
- Tom Kompas, R. Quentin Grafton and Nhu Che, (2010), 'Bioeconomic Losses from Overharvesting Tuna,' *Conservation Letters*, 3, 177-83. [Impact Factor: 4.69].
- R. Quentin Grafton, Tom Kompas, Chu Long and Nhu Che, (2010), 'Maximum Economic Yield,' *Australian Journal of Agricultural and Resource Economics*, 54, 273-80. [Impact Factor: 1.06] (33 citations).
- Tom Kompas, Cathy Dichmont, Andre Punt, A. Deng, Tuong Nhu Che, J. Bishop, P. Gooday, Y. Ye and S. Zhou, (2010), 'Maximizing Profits and Conserving Stocks in the Australian Northern Prawn Fishery,' *Australian Journal of Agricultural and Resource Economics*, 54, 281-99. [Impact Factor: 1.06] (38 citations).
- Cathy Dichmont, Sean Pascoe, Tom Kompas, Andre Punt and R. Dung, (2010), 'On Implementing Maximum Economic Yield in Commercial Fisheries,' *Proceedings of the National Academy of Sciences*, 107, 16-21. [Impact Factor: 9.77] (79 citations).
- Tom Kompas, Tuong Nhu Che and R. Quentin Grafton, (2008) 'Instrument Choice and Uncertainty,' *Land Economics*, 84: 652-666. [Impact Factor: 1.56].
- R. Quentin Grafton, Tom Kompas and Ray Hilborn, (2007), 'The Economics of Overexploitation Revisited,' *Science*, 318, 7 December, 1601. (180 citations).

The University of Adelaide — Fertiliser Technology Research Centre

Sector: Public funding agency, private industry, agricultural sector.

Sources of Support: University of Adelaide; Grains and Research Development Corporation; CSIRO; The Mosaic Company, LLC (USA).

Purpose of programme/project

There is no doubt that food security is one of the grand challenges facing the world. Researchers at the University of Adelaide's Waite Campus, building on a long history of agricultural advances, are working on crop nutrients to help food producers worldwide meet the challenge of feeding some 9 billion people by 2050. Mineral nutrients are a major contributor to enhancing crop production, as well as in maintaining soil productivity and preventing soil degradation.

Summary of collaborative approach

The Fertiliser Technology Research Centre (http://www.adelaide.edu.au/fertiliser/) is a University of Adelaide Research Centre located within the School of Agriculture, Food and Wine. The Centre focuses on the understanding of fundamental processes controlling fertiliser efficiency in a wide range of soils globally, using a combination of spectroscopic, speciation and radio-isotopic techniques. Researchers manage and conduct experimental work under laboratory, glasshouse and field conditions to develop more effective fertiliser formulations to optimise their efficiency. They utilise their expertise in soil chemistry, fertiliser technology and plant nutrition. Specifically, in developing novel fertiliser formulations, advanced isotopic and spectroscopic investigations of fertiliser efficiency, and field scale agronomy trials.

The Centre was established in 2007 via a partnership between the University of Adelaide and US-based global fertiliser giant, the Mosaic Company, LLC., the world's largest phosphate and potash fertiliser manufacturer. Under an agreement with the University's commercial development company, Adelaide Research & Innovation Pty Ltd, Mosaic agreed to fund research at the new centre in return for commercialisation rights and a share of the intellectual property, initially signing a $5 million five year agreement.

Mosaic originally approached the University after reading about some of its research, and following recommendations from others in the industry. The strategic alliance started modestly with one small project, but expanded into a long-term collaborative venture, with Mosaic choosing Adelaide to be its key research and development provider globally. The scope of the Centre was further expanded in 2009 via a partnership between the Mosaic Company and the Australian Grains Research and Development Corporation, one of the world's leading grains research organisations. The Centre is located on the internationally-renowned Waite Campus, which represents one of the largest groupings of agricultural-related researchers in the world.

Additional support has also been provided by the Australian Meat and Livestock Association, the International Zinc Association, the South Australian Grains Industry Trust and the Australian Research Council.

Analysis of collaborative approach

The Centre is led by Professor McLaughlin AM, a Research Professor in Soil Science at the University of Adelaide and a Science Fellow at the CSIRO Land and Water Division. He holds one of the few joint appointments between CSIRO and Australian universities. The innovative work which Professor McLaughlin and his research groups have conducted has seen numerous breakthroughs in improved environmental assessment and management, the development of new fertiliser delivery systems, and a greater understanding of the interactions of nutrients and the environment. ln particular, his research as Foundation Director of the Centre, has been instrumental in developing an understanding of the mechanisms behind the effectiveness of fluid fertilizers in low rainfall cropping systems, and translating this knowledge into commercial outcomes.

The arrangement sees University researchers and PhD students working with Mosaic's agronomists and engineers to develop and test different fertiliser compounds. Each compound is benchmarked under realistic field situations using advanced isotopic tracing techniques. They are also tested using soil from different countries and under differing conditions, all with the aim of enabling producers to harvest more crop from the same amount of added nutrients; or the same amount of crop for less added nutrient. The end result is more food for the world with less financial impact to the grower.

There is also a benefit to the environment as the research uncovers methods of producing food while minimising harm to delicate ecosystems.

The work performed by the University is assisting Mosaic to advance new formulations rapidly through the product innovation pipeline, and to screen a larger number of promising products and techniques to developed commercially viable and agronomically effective new fertilisers.

In August 2015, the Mosaic Company Research signed a new five-year, $8.5 million partnership agreement between the University of Adelaide to support the continuing work of the Centre. Research over the next five years will be focussed around developing fertilisers using nanotechnology and other novel materials and formulations for enhanced efficiency and minimised environmental impacts. Farmers are expected to benefit from a reduction in the cost of manufacturing multi-nutrient fertilisers.

Details and analysis of impact

Mosaic, together with the team of researchers from the University of Adelaide, have been able to develop new techniques to develop and screen new products that are able to:

- Increase fertiliser efficiency
- Increase crop yield for farmers
- Increase the value of crops for human nutrition

- Produce food while minimising adverse environmental effects.

Some of the specific outcomes from the Fertiliser Technology Research Centre to date have included:

- a model to predict release rates of nutrients, in particular sulphur, from complex multi-nutrient fertilisers
- manufacturing methods to optimise micronutrient fertiliser efficiency
- rapid tests to evaluate fertiliser effectiveness
- new dual-release micronutrient fertilisers
- a better understanding of the impact of new raw materials on fertiliser quality.

Under the collaboration agreement, three new technologies have been submitted for patenting and are under more extensive field and commercial evaluation, and two rapid methods to screen new fertilisers for effectiveness have been developed and published in the scientific literature or presented at international conferences. The quality of the fundamental science underpinning this work has been recognised by several prestigious international prizes awarded to Professor McLaughlin.

The Centre's researchers have tested fertilisers targeted at a variety of countries and regions, including Brazil, Argentina, Turkey and North America, using soil sent under strict quarantine conditions.

According to Professor McLaughlin, the biggest markets for Mosaic fertilisers are North and South America, with the latter being a growing market.

The global commercial impact of Professor McLaughlin's research in soil contamination is also evidenced by his collaboration with a South Australian small-to-medium enterprise (Ziltek Pty Ltd) to commercialise novel soil assessment and remediation strategies, and his team's findings have now been patented in Australia, New Zealand and USA and commercialised by Ziltek Pty Ltd, and the technologies (Remscan® and Rembind®) were released globally in 2015 (see www.ziltek.com.au/).

One of the hallmarks of world-class researchers is the ability to evolve their work continually, investigating new ideas, methods and techniques. As Centre Director, Professor McLaughlin is presently heading the development of leading-edge fertiliser technologies to match nutrient supply to crop demand, and identify new efficient fertiliser formulations. This work is making extensive use of nanotechnology, and advanced tracing and imaging techniques to probe reactions of fertilizers with soils. As one particular example, with funding awarded by the Australian Research Council (2015-2017), he is leading an innovative project looking at the potential for engineered graphene-based nanofertilisers to improve crop nutrition. The outcomes will be a meaningful contribution to the advancement of scientific knowledge, specifically in the new emerging field of nanobiology and 'nanoagriculture'.

The Mosaic Fertiliser Centre has been successful research and development initiative, combining the longer-term commitment and expertise of university researchers and access to world-class facilities, with external public and private funding resulting in commercial, environmental and social benefit.

The University of Adelaide — Better beer

Beer is big business in Australia—which means barley production is also big business.

In fact, with an annual farm-gate value of $1.5 billion, it's this country's second largest field crop. What's more, Australia makes up more than 30 percent of the world's malting barley trade (and about 20 percent of the world's feed barley trade).

What many beer drinkers may not realise, however, is that the University of Adelaide plays a big part in the barley that eventually becomes the beer we drink around the barbecue.

It's also integral in the development of barley for export into the Asian market, which uses a different brewing process to that used here.

In most Asian style beers, a solid form of starch, such as rice, sorghum or corn is added as additional sugar in the brewing process, whereas Australian beer is brewed using actual sugar.

All this means in simple terms, is that barley used for the export market needs to work harder to convert the added starch into sugar.

With the help of the university's Barley Program, led by Associate Professor Jason Eglinton, the Australian barley industry has raised the bar on new varieties designed for the 'starch adjunct'. In fact, the quality of Australian malting barleys is now considered the best in the world by international customers.

The efforts of Australia's barley breeders have now delivered several new varieties, increasing market share and improving productivity of Asian brewers.

Bespoke varieties have also been developed in collaboration with key brewers to specifically suit their requirements.

SouthernStar was produced with Sapporo Breweries and Charger was bred with Carlsberg and Heineken Breweries for exclusive use in their premium beer brands.

In the meantime, back home, varieties developed through the Barley Program are dominating the domestic brewing market and a new variety — Navigator — will add more value to the Australian industry.

'Navigator has a lot going for it,' said Associate Professor Eglinton. 'It sets a new benchmark for the amount of beer that can be produced from a tonne of barley and for farmers the physical grain quality and yield potential are also significantly improved.'

Barley breeding first began at the University of Adelaide in 1956 and since then varieties developed at the Waite Campus have accounted for more than 50 percent of national production. The broader barley breeding program has received significant support from the Grains Research and Development Corporation (GRDC) and a consortium of other industry players.

New barley varieties have improved farm profitability with impressive yield increases across South Australia averaging 4.4 percent per annum.

These researchers have been working closely with both the barley and the brewing industry for nearly 60 years for the benefit of all.

The University of Adelaide — Making Babies

For most of us, making a baby is a natural and straightforward process. But for others, it can be less enjoyable, more stressful, and a lot more scientific.

It was only a generation ago that those who couldn't conceive the conventional way were left childless.

Thankfully, for those people and society as a whole, researchers at the University of Adelaide have learned a great deal about reproductive health over the past decades — beginning long before Louise Brown, the world's first IVF baby, was born in England in 1978.

Today, IVF is a common procedure in Australia with approximately one in 25 babies born from IVF. In particular, research conducted at the Robinson Research Institute covers the entire spectrum of reproductive health—from the health of women pre-conception, throughout pregnancy and childbirth and through to early childhood development.

This knowledge has been passed on to assist thousands of couples to have healthy babies and has culminated in the development of a number of novel inventions, such as EmbryoGen®, a breakthrough treatment for women undergoing IVF after one or more previous miscarriages.

EmbryoGen®, developed by the University, Adelaide Research and Innovation and Dutch company Origio, is an innovative fertility culture medium for growing embryos, which can improve implantation rates by up to 40 percent.

It works by mimicking the mother's natural signalling molecule — providing a cytokine, GMCSF — to protect the embryo from stress, which makes it stronger and more robust in the early stages following an embryo transfer.

The product is the culmination of more than two decades of work for Robinson Research Institute Director Professor Sarah Robertson.

Attracted by the science, and convinced of the commercial applicability of the technology, Origio licensed the culture medium, and undertook the world's largest fertility media study to verify Professor Robertson's research.

In a major commercial breakthrough, the US Food and Drug Administration (FDA) approved EmbryoGen® to be marketed in the US, clearing the way for its use in one of the world's biggest markets.

The US decision follows earlier decisions by authorities in large markets such as Europe, China and the Middle East to allow the use of the treatment.

Australian authorities, however, are yet to approve the widespread commercial use of EmbryoGen®, but Professor Robertson expressed confidence it would eventually be available to help Australians undergoing IVF.

The research being done today at the Robinson Research Institute builds on years of local research and developments in reproductive technology, beginning in 1971, when Adelaide became home to Australia's first sperm donor program and sperm bank through the University's Obstetric and Gynaecology Department.

In 1987, the University was the launching ground for the State's most successful fertility company, Repromed Pty Ltd.

Acquired by a private consortium in 2006, the proceeds from this commercial venture funded more research, and Repromed continues to make a fundamental difference to families in South Australia every day.

The true impact of reproductive research at the University is difficult to quantify — but it's obvious when you meet a family who've had their dream of starting a family come true.

The University of Melbourne — CSL partnership at the Bio21 Institute of Molecular Science and Biotechnology

CSL is Australia's largest biotechnology company and a global leader in plasma-derived therapies and protein-based medicines. It has a successful track record in the development of innovative medicines to prevent and treat serious human diseases and develop innovative medicines for global markets. The CSL Group is headquartered in Melbourne and has a substantial research and development presence with extensive ties to researchers at the University of Melbourne and neighbouring medical research institutes and hospitals.

In 2007, CSL relocated part of its Melbourne-based Protein Therapeutics Research Group to the University's Bio21 Institute of Molecular Science and Biotechnology. This Group has established close links with many of the University's researchers and higher degree students located in the Bio21 Institute. Over the next few years the CSL Research Group will double in size (to around 150 scientists) and will become a major hub of research activity with translational impact.

The co-location of CSL and University researchers within the Bio21 Institute has resulted in important synergies and facilitated the translation of fundamental knowledge to towards clinical outcomes. Specific benefits and outcomes of this relationship include:

- the development of a candidate vaccine for chronic and acute peridontitis in collaboration with the Oral Health CRC
- the development of new protein-based therapeutics with the potential to treat acute and chronic inflammation/autoimmune diseases and cancers
- enhanced links and investments involving University researchers and neighbouring hospitals and medical research institutes
- a substantial increase in collaborative research supported through successful applications to the ARC Linkage grant scheme and
- exposure of the next generation of scientists, including students at the neighbouring Elizabeth Blackburn Science High school (part of neighbouring University High School), graduate research students, and early career researchers, to opportunities in the biotechnology industry.

The University of New South Wales — Brien Holden Vision Institute

Sixty million people around the world now wear safer, more comfortable contact lenses manufactured using a scientific formula developed at UNSW.

Purpose of Program

Roughly 125 million people around the world wear contact lenses. Almost all of them have experienced the problems of hypoxia — a condition that arises when the cornea doesn't receive enough oxygen.

Contact lenses create a physical barrier to the surface of the cornea. Hypoxia, associated with long-term lens wear, can lead to conditions such as corneal swelling, redness, blood vessel growth, thinning of the cornea, vision loss, predisposition to inflammation and infection, and reduced wearing time.

Summary of Collaborative Approach

In the 1980s, UNSW scientists including Brien Holden and George Mertz wrote the recipe for hypoxia-free contact lenses. They did this by running trials with subjects sleeping in lenses to determine the optimal oxygen transmissibility.

In the early 1990s, Australian and global collaborators were brought together in the Cooperative Research Centre for Eye Research and Technology with industry partners to implement 'the recipe' and engineer the lenses. The permeability threshold they needed to achieve was known as the Holden–Mertz Criterion. Brien Holden and Arthur Ho led the global project, including up to 90 other researchers working across eight locations around the world.

The result were revolutionary contact lenses containing both silicone and hydrogel polymers in a structure that allowed the transmission of oxygen as well as fluid through the lens to the surface of the eye. The transmission of oxygen and fluid are both essential for eye health.

Industry partner CIBA (now Alcon) Vision Care called the silicone hydrogel contact lenses Focus Night and Day. The lenses virtually eliminated the problem of hypoxia and provided a platform for the delivery of many important therapies such as the slowing of myopia in children.

Analysis of the Collaborative Approach

Involving a multidisciplinary approach to research, the Cooperative Research Centre for Eye Research and Technology (CRCERT) resulted in the co-development of a highly permeable silicone hydrogel lens (NIGHT & DAY™) which has revolutionized the contact lens market worldwide. This product could not have been achieved without collaboration of core participants (which included researchers at the Cornea and Contact Lens Research Unit and

the Graduate School of Biomedical Engineering at UNSW) in an innovative approach to solving the problem of hypoxia (lack of oxygen) to the eye due to wearing hydrogel lenses.

By 1990/91, the problems caused by a lack of oxygen (hypoxia) to the ocular surface during soft contact lens wear were universally recognised. Unfortunately the hydrogel materials from which contact lenses were then made were incapable of providing a solution because their chemistry prevented them from being made either thin enough, or with sufficiently high water contents to permit an adequate supply of oxygen to be transmitted across their bulk.

Efforts to increase oxygen transmissibility by incorporating silicone moieties into the lens material had been previously tried but these attempts failed, mainly due to the resulting alteration of the material properties of the lens. Despite excellent oxygen transmitting properties, the introduction of silicone created lenses that bound tightly to the eye and had very poor wetting characteristics. In short, they had poor biocompatibility.

Recognising that resolving these issues would require a multidisciplinary approach, researchers from the Cornea & Contact Lens Research Unit (CCLRU) at UNSW persuaded Ciba Vision, (one of the major global contact lens manufacturers) to commit significant funds and personnel to setting up the SEE3 project within the Co-operative Research Centre for Eye Research and Technology (CRCERT). This collaboration brought together polymer chemists, material scientists, clinical scientists, biomedical engineers and biologists from Cornea and Contact Lens Research Unit (CCLRU) and Graduate School of Biomedical Engineering at UNSW, CSIRO and Ciba Vision with the common aim of developing highly oxygen permeable contact lens materials that were capable of behaving in a clinically acceptable way when placed on the eye.

Three properties are required to allow long term continuous contact lens use:

- the ability to allow oxygen to permeate to the surface of the cornea beneath the lens to prevent hypoxia (a lack of oxygen), responsible for problems such as red eyes, corneal swelling, cellular abnormalities and blurred vision
- ‘wettability’ — in the case of contact lens use, to allow a tear film to form around the contact lens, necessary for eye comfort and the prevention of substantial deposits
- movement of the lens on the eye during normal blinking to prevent stagnation of the tear film, tissue injury and debris accumulation

The SEE3 project was initiated to overcome the difficulties of combining these desirable properties into a material with both suitable optical properties and appropriate biocompatibility.

Research within SEE3 was divided into 5 main areas: i) Bulk material; ii) Surface Modification; iii) Ocular; iv) Material evaluation; and v) Clinical Evaluation. UNSW researchers contributed to the Ocular, Materials and Clinical research. Other research centres involved in the collaboration were CIBA Vision, CSIRO, CRCERT and CRU Basle.

The SEE3 project began in 1992, and the key patents were awarded in 1998, with the first product to market in 1999.

During the course of the project, many novel materials were synthesised. As there were three distinct polymer chemistry groups within the collaboration (CSIRO, Ciba Atlanta and CRU, Basle) each pursued a different chemical approach to the problem. Examples included perfluroployethers, acrylates, polyurethanes as well as silicone hydrogels.

In many cases, poor intrinsic biocompatibility of the bulk polymer required the surface to be modified in a separate process to improve behaviour. Plasma modification and polymer grafting were just two of the approaches investigated.

Insights from the Ocular research group informed the other groups of properties desirable to achieve biocompatibility. For example, a model eye was developed to permit the wettability evaluation of prototypes before going through pre-clinical certification procedures.

Evaluation of each candidate involved extensive laboratory study of its physical and biological properties followed by clinical study, first in an animal model then in human trials where appropriate. Feedback of information from these evaluations resulted in modified and alternative formulations. Over the course of these activities an understanding of the diverse factors necessary to create an acceptably performing contact lens with superior oxygen transmitting properties was developed and this knowledge resulted in several patents, the most important being detailed in United States Patent No. US 5,760,100 and its antecedents. This is the Nicolson patent on which all current silicone hydrogel contact lenses are founded.

The final material candidates were entered into increasingly extensive human clinical trials which culminated in the final material being selected based on its overall performance characteristics. This material, which became known as Lotrafilcon A, was then subjected to the full range of regulatory evaluation required to permit its approval by the FDA in the United States and Night & Day™ contact lenses made from this material were launched commercially during late 1999.

Subsequent products developed by CIBA Vision based on the Nicolson patents include O2Optics™ / Air Optix™ (alternative names for the same product), Air Optics Toric™ and Air Optix Multifocal™. These products are based on Lotrafilcon B which was developed by Ciba in conjunction with the Vision CRC (formerly CRC for Eye Research and Technology i.e. CRCERT).

In 2010, the MyoVision™ spectacle lens was released by industry partner Carl Zeiss Vision. The spectacle lens has demonstrated an ability to slow the progress of myopia by 30 per cent in children 6 to 12 of age, where the child has a certain history of parental myopia.

Another ambitious research project — the Accommodating Gel, has now been licenced to industry partner Adventus Technology Inc. Commercial products derived from this technology may one day capture a significant portion of the vision correction market.

Impact of Program

The outcome of this project was the Night & Day™ contact lens made from Lotrafilcon A material. Launched in 1999 this was the first successful silicone hydrogel contact lens, lenses of this type have effectively eliminated the problems associated with hypoxia that were previously experienced by wearers (Papas et al 1997, Keay et al 2000, Covey et al 2001, Fonn et al 2002).

The key patents underpinning the development of the Night & Day™ contact lens are known as the 'Nicolson patents', each of which identify four UNSW researchers as inventors. These patents have been unsuccessfully challenged by other major players in the contact lens market (e.g. Vistakon/Johnson & Johnson, CooperVision and Bausch and Lomb) resulting in licensing arrangements with Ciba Vision. As such, technological innovations contained within the Nicolson patents have underpinned almost the entire current silicone hydrogel contact lens market.

Consumer uptake of these lenses has been rapid. Silicone hydrogel alternatives are now available in all contact lens modalities including extended wear, daily wear, daily disposable, astigmatism, and presbyopia. By 2011, silicone hydrogel lenses account for 73 per cent of all new lenses fitted in Australia, 68 per cent in the US and 47 per cent globally (Morgan PB et al., 2012).

Sales over the last 14 years have exceeded US$20 billion and the collaboration has generated over US$1 billion in research funds and over US$200 million in royalties for the CRC collaborating partners. Many of the royalties from the sale of these products have been reinvested in further research, postgraduate education and humanitarian programs to build sustainable eye-care systems in developing communities.

New projects under development include an advanced retinal imaging system, with the aim of making this crucial diagnostic technology reliable, accessible and affordable.

The University of Newcastle — Systematic Evaluation of Transportable Moisture Limit (TML) Measurement Methods for Iron Ore Fines Bulk Cargoes

Centre for Bulk Solids and Particulate Technologies, Newcastle Institute for Energy and Resources, University of Newcastle

Sector: Private Industry through AMIRA International

Sources of Support: Overall project budget $1.96 million

Purpose of programme/project

Bulk cargo shifting of mineral ores and concentrates has led to the recorded loss of sixteen ships and one hundred and thirty three lives over the past thirty two years. In the majority of cases, it is believed that the shifting was caused by bulk cargo instability due to excessive moisture content. The International Maritime Organisation (IMO) has established procedures for safe transport of bulk commodities, including the definition of three tests for the determination of Transportable Moisture Limit (TML). In 2012, in response to the loss of the ships, the IMO warned of the probable dangers of liquefaction associated with the carriage of iron ore fines, and established a correspondence group to define a specific schedule for iron ore fines for the next revision of the International Maritime Code of Safe Practice for Solid Bulk Cargoes (IMSBC) code. Major Australian and Brazilian Iron Ore companies came together to work collaboratively on this issue and as part of this the AMIRA P1097 project was initiated bringing together the expertise of the University of Newcastle, University of Auckland and CSIRO.

The AMIRA P1097 project aimed to advance the science and engineering that underpin the measurement of TML for shipping iron ore fines bulk cargoes, and to recommend the best methods for assessing an iron ore fines bulk cargo moisture limit to ensure ship stability is maintained in adverse sea conditions.

Summary of collaborative approach

What was the nature of the partnership/collaboration?

Partnership with AMIRA, University of Auckland, CSIRO & major iron ore companies in Australia and Brazil.

Was there a pre-existing partnership? How long has it been in effect?

Since 2008, TBS has conducted over 300 TML tests for 30 Australian and multinational producers of bulk commodities exports. These commodities include iron ore fines and concentrates, other metal concentrates (like lead, zinc, copper), bauxite, manganese, nickel laterites, coal with a number of other export commodities also tested. The companies and export locations that these commodities derive are global and include North America, South America, Sub-Saharan Africa, Asia and Australia.

What were the mechanisms employed to implement and manage the collaborative processes?

It can be very difficult to bring private companies that are competitors together to collaborate on research and development with universities. The mechanisms employed to facilitate this collaboration included:

- pre-existing AMIRA International intellectual property agreements
- rigorously following accepted anti-trust guidelines for meetings of competitor companies
- employment of a dedicated project leader to manage the complex interactions between companies and institutions
- regular review meetings between industry representatives and researchers
- establishment of a technical steering committee.

Analysis of collaborative approach

What were the contributions of each party? Were they appropriate and effective?

- University of Newcastle provided expertise in bulk solids handling, laboratory TML testing and modelling of sliding failure of iron ore cargoes under ship motion and estimation of the propensity of moisture to migrate through the ore cargo.
- University of Auckland provided geotechnical expertise, particularly in earthquake induced liquefaction of saturated soils, and the extrapolation of this knowledge into the area of potential liquefaction of cargoes under ship motion.
- CSIRO provided expertise in characterisation of the iron ore physical properties and mineralogy.
- Iron Ore companies provided samples and measurements of their iron ore fines under real shipment conditions, for validation of models developed by the researchers.
- Overall, the contributions of the different parties were extremely effective and synergistic, leading to excellent project outcomes.

What specific steps or activities were taken to support/achieve mutual interests and benefits, due to the different organisational drivers?

See above

What was most successful element of the collaborative approach?

The contributions from all the researchers (as described above) combined with the transport data from the mining companies led to the validation and ultimate acceptance of the IMO of the new iron ore fines TML test method. This provided a repeatable and reproducible bench scale test method where a safe moisture limit can be determined to ensure cargo stability is maintained in adverse sea states.

What lessons were learnt for future/ongoing collaboration?

Careful treatment of data to ensure confidentiality is maintained for the different miners (who are otherwise competitors) whilst still providing the technical team (researchers and miners) group with sufficient data to progress the research.

Details and analysis of impact

How well did the programme/project achieve its objectives?

The AMIRA P1097 project was judged to be a success, with a modified TML test for iron ore fines proposed and accepted by the IMO for inclusion in the next IMSBC code. This has been accepted and implemented in Australia by the Australian Maritime Safety Authority, and is currently in use for iron ore fines shipments. A draft international standard has been proposed based on this method.

What has been the impact of the programme/project (social, economic, commercial, community and/or other impacts)?

Mining companies faced potential safety problems with shipments of iron ore and/or unnecessary delays in shipments (leading to multi-million dollar losses), due to the use of TML tests that were developed for mineral concentrates which did not provide realistic TML values for iron ore fines. This project led to the development of a specifically designed and validated TML test for iron ore fines that ensures shipments are both safe and can still be loaded in a timely manner.

During the project, it became apparent that opportunities existed to improve moisture measurement and control for the iron ore industry, and that economic moisture reduction may also be possible due to moisture migration on conveyors. Moisture must be high enough in iron ore processing to suppress dust, yet low enough to ensure material handling issues do not occur, ensure any TML requirement is not exceeded, and to avoid necessary freight costs. Water reduction capability is particularly relevant for ores that are mined below the water table, wet processed, or just mined in a high rainfall area. In addition, the ability to further reduce water content in the ore has economic advantages throughout the transport chain where a one per cent reduction in moisture content can equate to multimillion-dollar transport cost savings.

How do or did you measure/evaluate the programme's impact? What was the time frame?

The timeline of work was developed and agreed by all parties at the commencement of the project. Regular meetings were carried out throughout the project to assess current progress and future relevance against the research timeline and redefine the research pathway when necessary. This culminated in the project meeting hard deadlines for presentation of results by the correspondence group at IMO meetings. This was done and accepted by the IMO and implemented by AMSA and Brazilian Maritime Safety Authorities.

Is there likely to be on-going impact?

Iron ore companies worldwide are now able to use the newly defined TML test for iron ore fines to ensure safe shipment of their products.

A 2-year collaborative AMIRA project 'Moisture Measurement and Control for Iron Ore Conveyor Systems' has been developed to address issues uncovered during the initial project. Respected research providers, TUNRA Bulk Solids (UON), will conduct it. The project proposed to address the following two critical areas:

- Develop an effective means of automatic calibration and monitoring of moisture through the ore on high speed conveyor belts for a range of iron ore mineral types, using a low frequency microwave sensor combined with a mineralogy detection device. This unique system will provide automatic moisture detection throughout the whole depth of the iron ore on the belt, rather than just at the surface.
- Exploit the tendency for moisture migration due to dynamic belt oscillation on high-speed conveyors to develop conceptual moisture reduction system designs for moisture liberation from an iron ore stream.

Sponsors for this project will benefit by having the ability to measure iron ore moisture content online and in real-time for a range of ore mineralogies via a global calibration matrix. Sponsors will gain exclusive access to this solution for the period to be agreed after the completion of the project. Sponsors will also benefit from understanding the mode of moisture migration and the rate of moisture migration through the definition of dynamic moisture migration characterisation curves specific to their ore and handling system. This design information will be used to identify or create economic moisture reduction systems where liberated water and/or a wet portion of the ore stream can be separated. It is envisaged that this separation would ideally occur at a conveyor transfer and any entrained ore re-processed and returned to the belt.

Currently TBS is working with the Australian coal industry on a coal specific TML methodology, which has been given interim approval for Australian coal exports to 1 January 2016 by the Australian Maritime Safety Authority (AMSA). This coal method is currently being assessed for international use through IMO.

Have there been any evaluations and/or follow up studies of the programme/ project?

- As mentioned above, a 2-year collaborative AMIRA project 'Moisture Measurement and Control for Iron Ore Conveyor Systems' has been developed to address issues uncovered during the initial project.
- Moisture migration and drainage of ores and other commodities have subsequently been and are still being assessed at the University of Newcastle.
- Also, TML research work has been conducted for coal, nickel, bauxite and manganese mining companies at the University of Newcastle.

Is there any specific data or other evidence of academic or other impact (e.g. citations, patents, start-ups, ongoing or long-term collaboration arising from the programme/project)?

- Draft ISO standard submitted to the ISO meeting in Brazil in 2014.
- Invitation to present a keynote presentation at the AusIMM Iron Ore 2015 Conference.

How did the collaborative approach contribute to the impact?

The project benefitted from contributions from a multi-disciplinary team of researchers with unique skillsets, which all combined to defining the conditions required for ore failure modes under the dynamic forces reflective of ship motions. These skillsets, combined with the transport data from the mining companies, led to the development of novel modelling techniques, which were validated against realistic ship motions. Overall, the contributions of the different parties were extremely effective and synergistic, leading to excellent project outcomes.

The University of Notre Dame Australia — AusCAN Collaboration, Institute for Health Research

A single-blind, randomised, placebo-controlled, parallel-group trial of the AusCAN Prevent© wheelchair re-positioning theory-based behaviour change program with real-time biofeedback of pressure injury risk — The MOVE Trial

Sector: The model in this case study was one of private sector and the patients in a tertiary metropolitan hospital involved in a medical device clinical trial.

Sources of Support: Grants (Neurotrauma Research Program, Harry Perkins Institute of Medical Research, WA Department of Health); In-Kind Support from Professor Michael Stacey's research group at the University of Western Australia; In-kind Support from Dynamic Control Inc, Christchurch, NZ - a biofeedback device manufacturer

Purpose of programme/project

The Problem Being Addressed

The AusCAN Collaboration group in Western Australia is a group of researchers from the University of Western Australia and the University of Notre Dame Australia who had identified an area of pressure injury prevention in patients with spinal cord injuries that required a medical device that provided biofeedback. An innovation based on Biofeedback was developed.

The Solution Being Achieved

Following a partnership with industry 5 units were provided in kind to the AusCAN Research Collaboration group to conduct a randomised controlled trial in a tertiary hospital in Western Australia. The results of the Phase 1 trial using the Healthy Chair© system (Dynamic Controls, Christchurch, NZ) indicated that full and partial pressure reliefs increased significantly from baseline. The Phase II study is tentatively scheduled to begin recruitment in January 2016.

The challenge of preventing pressure injuries in persons with spinal cord injuries

Pressure injuries develop in the buttocks' of persons with spinal cord injuries (SCI) due to the lack of normal sensory triggers to alter sitting postures that result in increased immobilisation. This trial, a world first, investigated whether the rate of re-positioning movements increases when using a behaviour change program that integrates real-time visual biofeedback from the new Healthy Chair© wheelchair system (Dynamic Control Inc, Christchurch, NZ). This state-of-the-art biofeedback system includes a data logger that continuously records the seat-buttocks interface pressures (Vista Medical Inc, Winnipeg, Canada), provides real-time algorithm-based risk feedback via an iPod Touch and prompts direction and duration of movement.

Biofeedback to cue pressure relief movements has employed interface pressure mapping. Wheelchair cushion-buttocks interface pressures are measured using a flexible mat that

measures the distribution of pressures on the sitting surface. These 'maps' are visually displayed to the individual using a smartphone app that also displays a range of related metrics such as pressure risk index, dispersion index and peak pressures or translated into a tactile input on the tongue. Proof of concept studies demonstrated that these systems are safe and acceptable to the participants. The results of the Phase 1 trial using the Healthy Chair© system (Dynamic Controls, Christchurch, NZ; http://www.dynamiccontrols.com) indicated the full and partial pressure reliefs of three out of the four participants increased significantly from baseline. The participant who did not increase was found to have an already high rate of performing pressure reliefs at baseline.

Figure 1. The iPod Touch provides the visual feedback (A). The middle number denotes the level of risk that the person has at that time (B). The higher the number, the higher the risk. This concept of graduated risk is depicted using an array of colours where green is low risk, yellow/orange is higher risk and red is the highest risk (C). The highest risk number is 99. It is based on a sophisticated algorithm based on duration of time sitting since last repositioning and the magnitude of the pressure of the buttocks on the mat.

Type of research

This is a Phase II single-blind, randomised, placebo-controlled, parallel-group trial with a qualitative evaluation of the theory-based behaviour change program and the new biofeedback technology at the end of the trial.

Primary Outcome

To determine whether a behaviour change program with real-time biofeedback from the Healthy Chair© wheelchair system increases the rate of full pressure relief movements of individuals with spinal cord injury whilst sitting in their power wheelchairs as compared to a comparator group.

Secondary Outcomes

1. To determine whether a behaviour change program with real-time biofeedback from the Healthy Chair© wheelchair system increases the rate of partial pressure relief movements of individuals with spinal cord injury whilst sitting in their power wheelchairs as compared to a comparator group.
2. To determine whether the scores on the Health Beliefs About Preventative Skin Care for Persons with SCI increase after using the behaviour change program with real-

time biofeedback from the Healthy Chair© wheelchair as compared to a comparator group.
3. Describe the writing behavioural goals/target behaviours related to pressure relieving for the behaviour change program.
4. Describe the acceptability and usability of the behaviour change program with real-time biofeedback from the Healthy Chair© wheelchair system.
5. Determine the cost-effectiveness of the treatment as compared with the comparator. The AusCAN Prevent Cost Diary© has been constructed for ease of tracking services and costs.

Summary of collaborative approach

There had not been a pre-existing partnership. The identification and acknowledgement of a particular problem and potential solution led to the formation of a partnership between university and a private company. That partnership was formalised during an application and award of a competitive grant to test a device. The collaborative effort began in 2014.

The partnership is maintained though regular face to face meetings/ telephone meetings/ written communications. A combination of informal exchanges, as well as formal reporting, works well for this partnership.

Analysis of collaborative approach

This is collaboration between publically funded research in Western Australia and a wheelchair control manufacturer in New Zealand which is the largest in the world.

Coalition Collaboration Model

In a community coalition, the focus of the collaboration is to concentrate the collective power of the members and focus it on action. Collaboration was based on shared goals and vision related to the action agenda. This coalition used structured memoranda of understanding to help operationalize the collaborative process. The project would not be possible by the university teams or the industry partner alone.

Contributions of the wheelchair control manufacturer are:

1. Equipment.
2. Training on the equipment.
3. Feedback and software design.
4. Industry focused problem solving and leadership; Joint collaborative effort with industry based researcher.

Contributions of AusCAN Research Collaboration group at Notre Dame and The University of Western Australia are:

1. Expertise in pressure ulcer prevention techniques, spinal cord injury rehabilitation, power wheelchair design, behaviour change theory and intervention design.

2. Facilitation of required Human Ethics Research Committee approvals for research sites.
3. Project management or oversight for the project.
4. Reporting and communication/ dissemination of results through state, national and international conferences.
5. Funds leveraged from Neurotrauma Research Program, WA.
6. Maintain confidentiality regarding the device and software.

Most successful element of the collaborative approach

The leadership qualities of the consultant for the industry partner were exceptional for project management, problem solving and flexibility.

Lessons Learned

1. Industry partners enhance innovative research.
2. Industry partners are essential to medical device innovation.
3. Innovative research enhances medical devices, especially in their software design and application.
4. Funds for onsite training are required.
5. Industry partnership established another industry partnership in Perth, Western Australia with the research group. There is a flow on effect with respect to industry partnerships and the research group.
6. The Partnership needs to be flexible and adaptable. The original industry leader left for new employment at the end of the training period so longer term projects should be prepared for changes in the original team.
7. Progress and annual reporting to a grant funder, along with frequent communications between the industry partner and the university based research team, provided continuous reflection and re-evaluation of the project.

Details and analysis of impact

The combination of industry-led business acumen and project management together with researcher-led expertise in proof-of-concept were the key collaborative elements for successful transfer of technology to the end-user.

Early impact from this project included growth of expertise in working with industry within the research team, proof of concept of the device and associated software, and a local ‘spin off’ partnership around improved technology in the operationalisation of the device itself.

Applying theoretical behaviour change modelling to this medical device was a world first. In addition to the traditional research outputs associated with this project, further investment in the commercialisation of the device has the potential to positively impact the quality of life of wheelchair bound patients thereby demonstrably improving health outcomes.

The University of Notre Dame Australia — Evaluation of Catholic Education Office of WA (CEOWA) Experienced Principals Program

End-user: Catholic Education Office of WA

Sector: Private Industry

Sources of support: Overall program and the evaluation was funded by the Australian Institute of Teaching and School Leadership (AITSL)

Purpose of programme / project

In 2013 the Western Australian Catholic education system endeavoured to create an innovative, integrated, cross-sectoral program to enhance leadership capabilities and health and wellbeing outcomes of experienced principals from Catholic, government and independent schools in that state. The program, the Experienced Principals Program, was conceived in 2012 and piloted in 2013 with 20 participants. The program was comprised of four integrated pillars: a 360-degree review of participant leadership capabilities followed by executive coaching to effect improvement; an executive health assessment and coaching with an exercise physiologist to enhance participant health and wellbeing outcomes; a theoretical program based on a nationally-accepted standard for principals; and a group 'mastery' project transacted in a non-educational setting. This project was a joint effort between the CEOWA and the researcher Prof. Michael O'Neill (University of Notre Dame Australia) to research and evaluate the pilot program and to suggest refinements for future iterations.

Solution to be achieved

As this was a pilot program for a very influential group of experienced principals across three sectors, data was sought to inform curriculum re-design and improvements for future offerings.

Summary of Collaborative approach

The researcher worked closely with the program designer Dr Shane Glasson within an action research model to gather qualitative data from participants of the perceptions of their experience of each module during the year long program. The researcher had access to survey data from the CEOWA as well as data from semi-structured interviews he carried out with participants at the beginning of the program and at its conclusion. The researcher had a pre-existing relationship with the CEOWA program designer as UNDA delivers units of study at a Masters level that are utilized by the CEOWA for other leadership programs.

Analysis of Collaborative approach — contributions of each party

The program designer invited the researcher to observe all elements of program delivery at every stage of the program. The Australian Institute of Teaching and School Leadership (AITSL) specifically funded the researcher for his time and the writing of a mid-year progress report as well as an end of year final report. Payments were made at the end of each report milestone.

Having the researcher attend as an observer of all presentations and activities within the program was a very successful element of the collaboration. This approach provided triangulation of data from surveys and qualitative interviews through field notes of observations and provided informal opportunities for the researcher to discuss the program with participants.

Details and analysis of impact of the evaluation

It might be argued that the project achieved its objectives well.

- The writing of a mid-year report allowed data from initial interviews and surveys at the end of various sessions to be utilized and fed back to the program designer. This allowed the designer to make minor refinements to the program in the latter half of the year.
- The researcher and designer presented a summary of the evaluation at an AITSL symposium in Melbourne. The innovative aspects of the programme's focus on principal health and wellbeing were very well received.
- All recommendations from the researcher were taken on board by the program designer to re-model a second iteration for 2014. (http://internet.ceo.wa.edu.au/ProfessionalDevelopmentResearch/LeadershipPrograms/Pages/The-Experienced-Principals-Program.aspx)
- The second iteration removed a mastery project in a non-school setting and replaced this with an action research project on the participant's school site aligned to the executive coaching experience. More time was recommended for the health and wellbeing component and this became a major element of the 2014 model. A report was provided to the Executive Director of Catholic Education. As a result the CEOWA made a commitment to fund the project in 2014. The Project is now also in its 3rd year of operation in 2015.
- There was a follow up evaluation of the 2014 program funded by the CEOWA which again provided a detailed written report which again made recommendations for refinements and improvements for 2015 delivery.
- The researcher and program designer are now submitting an article for publication in an international blind peer reviewed journal outlining the program and its iterations. There are very few reported professional development programs of this nature for very experienced principals and this evaluation has potential to contribute to the limited literature on this subject.
- Leadership in schools is a major research domain for The University of Notre Dame Australia. It is dominated by the practice of school leadership, and the development of student leadership in schools. The practice of school leadership has focused on

evaluations of professional development programs and service delivery from systems to schools, as demonstrated by this case study. The development of student leadership has centred on the role of school principals in developing student leadership. Notre Dame has conducted commissioned research with a wide range of Catholic Education Offices across the country via Schools of Education on both Fremantle and Sydney Campuses. Such collaborations inevitably lead to publications in scholarly journals in addition to the published reports they generate. The collaborations also support the development and delivery of relevant teaching.

The University of Western Australia — Research into Improved Safety of Mobile Jack-up Drilling Units in the Offshore Oil and Gas Industry: the INSAFE Joint Industry Project

Partners or end-users:

- Oil and gas Majors: ConocoPhillips, DONG Energy, ExxonMobil, Shell
- Certification bodies: American Bureau of Shipping
- Warranty Surveyors (engineering consultancies): Braemar Falconer, GEO-Danish Geotechnical Institute, Noble Denton, Global Maritime, Matthews Daniel
- Jack-up builders: Keppel Offshore and Marine
- Jack-up Owners and operators: ENSCO, Mærsk Drilling, Noble Drilling, Premium Drilling, Premium Oil and Gas Services, Transocean
- Site Investigation companies: Fugro
- Government Health and Safety Regulators: HSE UK

Sector: private industry

Sources of Support: Industry JIP funding: US$864,000

Background

This case study details a Joint Industry Project (JIP) established by three Universities, UWA, Oxford and National University of Singapore (NUS), to work with 19 offshore oil and gas companies and government regulators to research and develop guidelines for the prediction of geotechnical performance of their foundations during installation and removal of jack-up units.

Jack-ups are mobile drilling units that perform the majority of offshore drilling (oil and gas wells etc.) in water depth up to around 120m. However, modern jack-ups have lower reliability (safety from structural failure) than traditional fixed offshore platforms, with the majority of the accidents attributed to geotechnical failures. These can lead to rig damage, lost drilling time, and sometimes loss of life. Even the temporary loss of serviceability of a rig has major financial implications, considering that a modern jack-up costs over US$300 million and is hired out at over US$150,000 per day. The consequential cost to industry is estimated to be between US$10 and US$30 million per geotechnical incident.

This was the motivation for 19 oil and gas companies to work with UWA, Oxford and NUS on writing new guidelines for engineers to use in their daily prediction of whether a jack-up is safe to install and operate at a particular offshore site.

This 2 year JIP project was funded by the 19 oil and gas partners (US$864,000).

Purpose of programme/project

The recent safety record of jack-up installation and removal operations suggested that procedural improvements were necessary. One of the major improvements required was the reliability of foundation bearing capacity prediction for use in assessing jack-up foundation performance. In view of this, a Joint Industry (funded) Project 'JIP' was established to:

A. Review the state-of-the-art predictive methods established from recent geotechnical RESEARCH development (mainly the product of government funded research in the academic institutions, UWA, Oxford, NUS), calibrate these methods with CASE RECORDS (held by the industry partners), assess and determine the best methods for improving the reliable prediction of jack-up installation and removal.
B. Codify the above in a way that is readily accessible to analysts, and produce an up-to-date set of geotechnical site assessment and operational GUIDELINES.
C. Identify gaps in knowledge and experience and recommend future R&D work to close the knowledge gaps.

Summary of collaborative approach

The aim of the collaboration was to adopt the validated state-of-the-art methods within industry Practice, and present the methods in a 'user friendly' format within a document entitled: "Improved Guidelines for the Prediction of Geotechnical Performance of Spudcan Foundations During Installation and Removal of Jack-up Units".

In order to achieve this aim, the Contracting Academic Institutions involved in these research projects (UWA, Oxford, NUS) required real jack-up rig installation and removal data with which to validate and to verify their theoretical models (already published as journal papers). This is very valuable to academic institutions but relies on industry to release the data. The industry representatives (from Oil Companies, Drilling Contractors, Warranty Surveyors, Geotechnical Contractors, Consultants, etc.) provided jack-up foundation installation and removal records and the largest database of monitored offshore data on jack-ups was established (for joint use). The universities analysed the database and wrote the guidelines, with industry comments and input.

There were significant IP and confidentiality issues to be overcome in the project, with many of the cases sensitive due to previous jack-up failures at the sites. At least 50per cent of the first year was taken up negotiating confidentiality arrangements and sanitising the database (removing company names etc). However, the offshore database was, and remains the largest available database of real offshore jack-up records (and continues to be used by the academic participants).

Regular SKYPE meetings were held between the lead industry and academics, plus twice yearly workshop and meeting of all the participants.

This type of JIP would not have been proposed and established without trust and respect already established between the academics and the industry partners. These pre-existing relationship were established by the academics being members of industry committees,

such as membership for over a decade of the International Standards Organisation (ISO) committee charged with drafting the ISO 19901-5 (Site assessment of jack-ups guidelines), previous ARC Linkage projects, industry funded research, previous patent applications etc. The academics had also conducted 'industry sabbaticals' in the offices of some of the industry partners.

Analysis of collaborative approach

The drivers for the University partners was to see the new analysis methods that they had developed (through laboratory testing, theory and numerical analysis) proof tested against real offshore data and then codified for industry use.

The industry driver was that existing methods they used were >30 years old, developed for small footings and often inappropriate to the larger jack-up problem. There was a perception that the newly developed theories from UWA, Oxford and NUS would prove more accurate and reliable, however, this needed to be proven on real cases. They wished to provide data to prove this. Further, they wished to have a codified guidelines they could use (translating the often journal papers of the academic to real situations faced offshore). They saw the academics as more independent in writing this guidance, but also wanted it agreed upon through consensus across the different industry sectors (see list of stakeholders above).

There needed to be clear understanding, clarity and agreement of the drivers in the JIP set-up and the contractual arrangements. Though some conference papers summarising the project eventuated, the academics needed to accept that this was not going to be an avenue to improve many of their traditional performance measures (journal papers, citations, etc).

The most successful outcomes were establishing the database of cases and publishing the guidance document (one of the key documents used worldwide to assess jack-up installation, alongside the new ISO 19901-5 document).

Details and analysis of impact

Direct Impact:

1. **Guidance document now widely used internationally**. Improved guidelines for the prediction of geotechnical performance of spudcan foundations during installation and removal of jack-up units. RPS Energy Report Number EOG0574-Rev1. Final Guidelines of the InSafe Joint Industry Project 124p. Now available to all industry at http://insafe.woking.rpsplc.co.uk/Default.asp. These guidelines are freely available and are rapidly becoming best practice in the international industry.
2. **Aspects of the INSAFE guidance were written directly in ISO 19901-5, the new international standard for jack-up installation**. Around ¼ of the InSafe document has been picted up word for word into ISO. Expect further additions over the coming decade.
3. Though it is difficult to assess this, there is anecdotal evidence of improvement in assessments and reduction in offshore incidents.

On-going impact: The third objective of the project was to define knowledge gaps and new research proposals. These are being acted on by the industry and universities, though usually with bilateral arrangements. For instance, UWA has had two linkages projects with the industry partners, filed a number of patents and developed software incorporating the guideline's methods (now used by a number of the industry partners).

Collaborative approach: The university and industry partners could not have achieved the final impact without working together. The universities gained access to offshore data, exposure of their new methods and a translational output of their methods for practical use. Industry gained research translated into a format that they could use.

University of Canberra — People and Place in Australia

The survey is funded by multiple external organisations each year. In 2013 these included the Murray-Darling Basin Authority; Murrumbidgee Catchment Management Authority; Murray Catchment Management Authority; and Berrigan Shire Council.

Other supporting partners contribute expertise, advice, communication and distribution support. More than 100 agencies and organisations, from the National Farmer's Federation to the National Rural Health Alliance, local councils, and landcare groups, assist in promoting the survey and encouraging participation each year, as well as contributing to a collaborative process of survey question design.

Research partners: ANU; CSU; USQ; Australian Bureau of Agricultural and Resource Economics and Sciences

Sources of Support: Funding support provided through the Collaborative Research Network programme, comprising the following: cash and in-kind contributions from government and other partners.

Preamble

In our response to the *Review of Research Policy and Funding Arrangements for Higher Education Issues Paper*, the University of Canberra proposed the following definition for Industry:

Industry: The collective term for establishments and enterprises- both private and public – that engage in activities designed to produce benefits for society.

The Case Study presented here showcases an example of research- industry collaboration initiated by the University of Canberra that supports our definition of industry.

Context

The wellbeing of people in rural and regional Australia is shaped by many factors, often different from those in urban Australia. Better understanding of these factors and their impacts can help policy and decision makers frame approaches that improve wellbeing for rural Australians. With support from the Collaborative Research Network and many other sources, Dr Jacki Schirmer and Professor Helen Berry, from the UC Centre for Research and Action in Public Health, developed and conducted this innovative, policy-relevant project which has grown into an ongoing national survey conducted annually.

Summary of Project

With financial support from a number of partners, UC conducted a major survey of wellbeing in regional Australia, involving over 9,000 participants. Wellbeing is the outcome of many different influences that interact with each other in complex and dynamic ways. Amongst other things, wellbeing is typically associated with concepts such as quality of life,

health, liveability and life satisfaction. Internationally, many organisations monitor wellbeing as a measure of progress.

The Regional Wellbeing Survey addressed an important gap in understanding of a critical sector in Australia by examining the subjective wellbeing of people living in rural and regional areas of Australia, including how they are experiencing and responding to the many changes occurring in their communities. For example, the Murray-Darling Basin Authority is implementing large-scale reform of water management which includes significant reduction in water available for irrigation. The survey provided a critical tool for the Authority to understand the perceptions of the community concerning these change and their impact on individual and community wellbeing.

The outcomes of the survey provided new, reliable information about the wellbeing of both people and communities across rural and regional Australia. The scale of the survey enabled the researchers to interrogate it for specific perspectives on, for example, the influence of water reform, coal-seam gas development or fly-in fly-out mining on individual and community wellbeing.
Some areas of investigation and findings included:

- Reasons for youth outmigration from rural areas
- The importance of volunteering
- The role of leadership
- The nexus between access to different forms of capital and wellbeing. This includes financial capital, human capital, institutional capital, social capital, physical capital and natural capital.

The results of the research were launched in July 2014 by the Honourable Fiona Nash, then Minister Assisting the Minister for Health and have been published and widely reported. Because the survey results can be tailored to the interests and questions of a specific area or issue, they have attracted keen interest from local communities and from policy makers.

Notably, the results are now being used in shaping policy and reporting by the MDBA, NWC, ACT Commissioner for the Environment, Victorian Department of Economic Development Land Transport and Resources, National Farmers Federation, National Rural Health Alliance, NSW Office of Environment and Heritage, Federal Department of Agriculture and Water Resources and many regional bodies.

Due to the success of this project and the wide interest it has attracted from stakeholders, the survey will continue to be supported and conducted on an annual basis. The 2014 survey was successfully conducted with funding from multiple external stakeholders, and achieved 12,125 responses. In 2015, a total of $550,000 funding was sourced from multiple contributors, including the Murray Darling Basin Authority, Victorian Department of Economic Development Land Transport and Resources, NSW Office of Environment and Heritage and Department of Agriculture and Water Resources.

Some upcoming results expected in late 2015 include the following:

- Farming and agricultural report: this examines the wellbeing of the 3,700 farmers who participated in the survey in 2014; the report is being released in October 2015
- Environmental and natural resource management report: this relates how rural and regional Australians are engaging in environmental and natural resource management, how they feel about their landscape and environmental health, and how they spend their time outdoors

The collaborative approach

The project adopted a collaborative approach to the survey design and data collection, drawing upon a wide range of rural and regional organisations. Each year, organisations are invited to participate in surveys and workshops to identify topics to include in the survey and to help inform question design. They are also invited to help organise local presentations of survey results, and often invite the researchers to present at local events (most recently, on October 23rd 2015, Dr Schirmer conducted a workshop in Wagga Wagga with 33 representatives of local governments across the Murray and Riverina regions of NSW, to discuss how best to incorporate survey data into their strategic planning). Early presentations of results are given to these groups, and they are asked to comment and provide guidance on interpretation, assisting the researchers in their understanding of on the ground changes driving the shifts seen in the survey results. These end users include over 100 organisations with an interest in rural and regional issues, from local governments to regional development committees, natural resource management groups, farming groups, and community organisations. As well, researchers from the Collaborative Research Network's other projects were closely involved, contributing questions that collected data to inform their work on farmer exit, structural adjustment, migration, resilience and other topics. Dr Schirmer invested much time in developing and refining the survey and in working closely with research collaborators to ensure that the survey could address many aspects of rural wellbeing. Additionally, she worked closely with government agencies to understand their issues and needs, to build trust and to plan the analysis and release of survey results. This substantial investment of time and effort has been rewarded with strong, ongoing support for the survey.

Details and analysis of impact

- **Berrigan Shire Council** is drawing on the survey data to help analyse the factors in their community that support local wellbeing, such as where liveability of their community is better and poorer, the economic and social wellbeing of their residents, and how able their residents feel to engage in local planning and community engagement processes.
- **Murray Local Land Services** are drawing on the survey data to help design indicators to monitor the social and economic outcomes of investment in natural resource management in the Murray region of NSW

- The **Murray-Darling Basin Authority** is using the data together with other sources of information to assess the impact that Basis water reforms have had on social and economic outcomes in the Basin
- The **National Water Commission** invested in customised analysis of the survey data to produce indicators measuring social outcomes of water reform across Australia. These were published in the 2014 Triennial Assessment report
- The **Rural Industries Research and Development Corporation** are combining survey data with information from other sources (such as the Australian Bureau of Statistics) to better understand the value and contribution of agriculture to the Riverina region of New South Wales
- A collaboration between the **Victorian Department of Environment and Primary Industries DEPI)** and the **National Centre for Social and Economic Modelling (NATSEM)** is exploring the potential for using the survey data to estimate the effects on farm households of 'shocks' to the agricultural sector

Other Impact: academic

The findings of this project have had had important application for 7 other projects in a range of disciplines conducted as part of the CRN. This includes areas of environmental studies, economics, governance, public health, and arts and design, to name a few. This cross-disciplinary reach has in turn been instrumental in broadening the scope and application of research being conducted at UC , strengthening collaborations with a diverse range of partners, and attracting interest from new research collaborators.

These rapidly developing longer term partnerships will enable a source of data that provides value to the university and its researchers, to organisations with an interest in rural and regional Australia, and to people living in rural and regional Australia, into the longer term.

Due to the validation of the academic reach of the project and recognition of the potential for further cross-disciplinary collaboration and application of work conducted since the development of the well-being survey, Dr Schirmer has been appointed for an additional 5 years to continue her work at UC as a joint appointment of the Institute for Applied Ecology and the Health Research Institute. This represents a serious commitment to furthering cross-disciplinary collaborations and growing two important areas of research focus at UC — health and environmental studies — which are committed to finding solutions to the real world.

University of Queensland/UniQuest Pty Limited — Johnson & Johnson

Name of research programme: Strategic Industry Engagement Programme

Industry Partner: Janssen-Cilag Pty Limited (Janssen), a pharmaceutical company of Johnson & Johnson

Sector: Pharmaceutical, medical devices and consumer products

Purpose of the programme

What was the objective of the programme? How was it different to technology transfer? What was the strategy? Profile of target companies? How did you systematically identify target companies?

Rather than focussing on a one-dimensional relationship and single collaboration, this case study details an innovative strategy to identify companies who have multiple interests and needs for innovation and how, as a result of a multi-dimensional relationship, a company's broader research agenda has been satisfied.

The University of Queensland (UQ) through its technology transfer and commercialisation company, UniQuest established a programme in 2011 which set out to build and maintain long-term relationships with key industry partners with the aim of entering into multiple research collaborations and commercial partnerships over time. Subsequently referred to as strategic industry engagement, the programme differed from traditional technology transfer in many ways.

The process did not begin with a single innovation or patent application being pushed from the university to numerous companies in the search for a commercial partnership. Rather, it was a strategy which began with the identification of innovation-seeking companies which could lead to multiple university-industry interactions for UQ over time.

The search criteria for innovation-seeking companies included open innovation behaviour, a track record of university collaborations and a commitment to funding R&D as measured by a positive R&D spend per employee. The pool of companies were then prioritised taking into account the company's research activity and business direction, the publicly stated technologies and capabilities they were seeking and the extent of the match with UQ's research strengths, innovations and capabilities (http://www.uq.edu.au/research/research-at-uq/research-strengths). It enables us to build from an individual collaboration or a pilot project into multiple collaborations over time, and if successful, up the 'partnership pyramid' (http://www.uniquest.com.au/industry-engagement) into a strategic partnership. Following the pilot project the parties look to other collaborative opportunities from those earlier identified qualified leads, and new potential projects co-identified by the parties in the post-deal environment, where trust has been formed resulting in mutual upward spiral of information sharing.

Implementation of the programme

What were the structural changes to enable delivery of the programme?

To implement the strategic industry engagement programme, UQ through UniQuest established an industry engagement ethos to focus on identifying target companies, developing and actioning pursuit strategies to close the qualified deal opportunities and apply key account management principles to yield multiple interactions, deals and impact.

The strategic industry engagement programme currently has a number of companies from different industries, including Australian and multinational companies, at various stages in the 'partnership pyramid'. For the remainder of this research-industry collaboration analysis, the case study focusses on UQ/UniQuest's strategic partnership with Janssen Cilag Pty Limited (Janssen), a pharmaceutical company of Johnson & Johnson as an exemplifier of how this approach has yielded successful results.

Summary of Collaboration Approach Targeting Johnson & Johnson

What was the pursuit strategy? What marketing collateral was required? What were the stages in development? What were the contributions of each party?

Johnson & Johnson (J&J), through its family of companies is engaged in the research and development, manufacture and sale of a broad range of pharmaceutical, medical device and consumer healthcare products. In 2013 and 2014, it was recognised by Forbes as the world's largest drug and biotechnology company taking into account profits, net assets and market value. Johnson & Johnson Innovation is a division of Johnson & Johnson (China) Investment Ltd. Johnson & Johnson Innovation focuses on accelerating early-stage innovation worldwide and forming collaborations between entrepreneurs and Johnson & Johnson's global healthcare businesses. Janssen Cilag Pty Limited (Janssen) is one of the Janssen Pharmaceutical Companies of Johnson & Johnson. The company was a good fit with UniQuest's target profile criteria, however being such a large high-profile company, the challenge for UniQuest was to differentiate UQ's world class research and get traction within J&J when so many other universities and biotechnology companies around the world were also targeting the company.

The initial exposure to J&J occurred when UQ's Professor Ranjeny Thomas presented a poster on her Rheumatoid Arthritis technology (an area of interest for J&J) at a major rheumatology conference in 2010 in the USA. This was noticed by Johnson & Johnson Innovation's Dr Michael Elliot who is responsible for scouting immunology opportunities.

There was no further immediate follow-up but this initial interaction would prove key. In 2011 UniQuest met with J&J representatives at the international BIO conference in the US. It was at this meeting that we presented our new marketing collateral that had been strategically compiled to summarise the UniQuest innovation portfolio for biotechnology and pharmaceutical companies — for the first time using a pipeline format which is the norm for the therapeutics industry — a marketing innovation itself in the technology transfer sector (this is now updated every 6 months and regularly receives positives

comments. The latest edition can be found at http://www.uniquest.com.au/discipline/health). In the case of J&J, it was noted at the AusBiotech Business Development Forum 2012 that from that discussion over a dozen projects matched with their strategic interests.

Ms Kathy Connell, Director of New Ventures ANZ for Johnson & Johnson Innovation, AsiaPacific Innovation Centre based in Sydney, continued to champion and coordinate people from J&J to evaluate the information provided by UQ and UniQuest about qualified lead projects. UniQuest proceeded into multiple non-confidential technical discussions, followed by a visit to Australia by Dr Paul Stoffels, Worldwide Chairman and Johnson & Johnson's Chief Scientific Officer, along with Dr Michael Elliot and Kathy Connell to hear technology pitches from a number of Australian universities. This included the UQ/UniQuest pitch about the Dendright technology as a treatment for rheumatoid arthritis (RA) from Professor Thomas. In the time since the rheumatology conference in 2010, UniQuest and UQ had continued to advance and optimise the technology filing new patent applications and maintaining existing ones. When Dr Paul Stoffels heard Professor Thomas' pitch he recognised the disruptive potential of this innovation and UniQuest initiated a discussion around a transaction with Janssen locally and globally with technical due diligence and agreement negotiation taking place in the following months.

Johnson & Johnson: the first deal

What was the nature of the partnership/collaboration? What were the contributions of each party?

The deal was announced in January 2012 and the media release below contains the information which is in the public domain regarding the contributions of each party, noting that it was a 'seed' sized amount of money, importantly a 'grant' and not an equity investment.

Innovative rheumatoid arthritis therapy receives backing from Janssen

January 16, 2012

Dendright, announced today that it has facilitated a strategic research collaboration agreement with Janssen-Cilag Pty Ltd in Australia, one of the Janssen pharmaceutical companies, to develop a promising treatment for a devastating immunological disease that affects millions of people around the world.

Under the agreement, Dendright Pty Ltd will receive an upfront seed grant to fund pre-clinical development of its treatment for rheumatoid arthritis (RA). Dendright remains wholly owned by UniQuest. No other terms of the deal were disclosed.

The 2012 seed grant provided Janssen-Cilag Pty Ltd in Australia, (Janssen) one of the Janssen pharmaceutical companies of Johnson & Johnson the opportunity to evaluate the Dendright technology as an innovative potential treatment for RA. It also allowed Janssen the opportunity to assess the ability of the research team to collaborate, to deliver the project

to industry expectations and start to build a formal relationship with UQ through this first collaborative project.

In 2013 Janssen entered into a follow on partnership to further develop and commercialise the Dendright technology for RA. The parties entered into an R&D collaboration and option to license agreement. Under the agreement, Janssen provided funding to support the preclinical development through to an Australian-based Phase I clinical trial and the development of companion biomarkers. It is a true collaboration with information sharing and advice from Janssen ranging from clinical to manufacturing to regulatory matters.

Johnson & Johnson: a deal pipeline from key account management

What were the mechanisms employed to implement and manage the collaborative process? What specific steps or activities were taken to achieve mutual interests and benefits, due to the different organisational drivers? What elements of the collaborative approach have made it successful?

A strong measure of the success of research partnerships is repeat business through multiple projects over time and two further deals were confirmed with Johnson & Johnson Innovation in the following few years after the first deal was signed.

A second deal with J&J was announced in June 2013 and a third deal in June 2015. The media release extracts shown below contain the information which we can publically disclose about the contributions in each. We continue to promote our pipeline of collaborative opportunities to Johnson & Johnson Innovation and we hope to broaden the area of our partnerships from pharmaceuticals into medical devices and consumer healthcare.

The success of the partnership with J&J was getting to know each other through the initial project and demonstrating a successful working relationship and the ability to deliver against milestones. Beginning with one project as a pilot has allowed UniQuest and UQ to develop that relationship which has in turn led to a more significant partnership encompassing multiple projects. The relationship, through effective open communication, smoothed any bumps in the program and has been further enhanced by the allocation by both parties of a key client relationship manager responsible for co-ordinating the partnership interactions.

IMB links with industry to develop new insecticides and pain treatments

28 June 2013

Researchers at UQ's Institute for Molecular Bioscience have been awarded five grants worth $2.4 million to work with industry on projects such as developing eco-friendly insecticides for crops and treatments for pain from spider venom.

The successful projects [include the] discovery and characterisation of novel spider-venom peptides targeting the human sodium ion channel Nav1.7 - $450,000 for Professor Glenn King, Professor Richard Lewis and Professor Paul Alewood, IMB; Dr Alan Wickenden, Janssen Research and Development LLC; and Katherine Connell, Janssen-Cilag Pty Ltd. *Redacted.*

UniQuest Announces Collaboration with Johnson & Johnson Innovation to Discover Small Molecule Therapies for Ankylosing Spondylitis

12 June 2015

UniQuest Pty Ltd, the technology transfer and commercialisation business of The University of Queensland (UQ), today announced it has signed a research and development (R&D) and license agreement with Janssen Cilag Pty Limited (Janssen), one of the Janssen Pharmaceutical Companies of Johnson & Johnson, to identify, develop and commercialise small molecule modulators of a biological target identified by UQ as being important for the treatment of ankylosing spondylitis, and potentially psoriasis and inflammatory bowel disease.

Under the terms of the agreement, UniQuest and UQ will be responsible for carrying out the three-year drug discovery program aimed at identifying and optimising novel small molecule modulators of the target in collaboration with Janssen immunology scientists. Janssen will receive exclusive worldwide rights to develop and commercialise the drug candidates.

Two key elements for the success of this collaborative partnership have been the critical mass of research excellence at UQ that attracted J&J in the first instance and the fact that the majority of UniQuest's projects are clinically relevant, in some cases being led by clinician researchers. UniQuest is well aware that research excellence and market need are at risk of going unmatched unless the opportunities are appropriately packaged to attract industry. UniQuest is a leading example of how this can be achieved. The industry experience in positioning UQ projects as well as the flexibility and expertise that UniQuest brings to deal structure negotiations have helped to build a mutually beneficial relationship with J&J that we look forward to further building over the coming years.

Impact: a project perspective

Partnership	Impact and potential future impact
2012 seed grant & 2013 rheumatoid arthritis R&D collaboration and option to license agreement Professor Ranjeny Thomas	Foundation patent application granted in US and AU. Continuation patent application in progress. Antigen patent application filed. Several scientific publications with most significant ones demonstrating proof of concept of therapeutic approach in a human study. Dendright technology subject to funded R&D agreement from Janssen avoiding need for diluting funding in start-up company. Janssen have further funded program since the 2012 seed grant. Financial and in-kind support also received from Arthritis Queensland.
2014 novel pain treatment from spider venom ARC Linkage agreement Professor Glenn King	Project and deal recognised in industry media — Fierce Biotech — as a top 20 notable pharma-academic collaboration for the year. Initial 18 month seed grant led to ARC Linkage agreement with in-kind and financial support from Janssen. Utilises novel peptides isolated from spider venom to find new treatments for pain. UQ/UniQuest provides access to world leading collection of venoms and capability in peptide therapeutics and ion channel pharmacology which leverages Australian biodiversity.
2015 drug discovery R&D collaboration and license agreement Professor Matt Brown	Translation of ankylosing spondylitis clinical findings in 3 year collaboration. Builds off UQ's expertise in genomics to translate patient specific data in to potential new treatments. Innovative collaboration structured to use UQ and UniQuest's expertise in clinical research and drug discovery in collaboration with Janssen's expertise in drug discovery and development to identify new candidate treatments.

Impact: a national perspective

The impact on economic returns to Australia stems from being able to retain drug discovery, preclinical and clinical development expertise and activities within Australia to develop new treatments relevant to the Australian population. Further development required to take the treatments to the market/patient may also occur overseas with our international partners and should not be perceived as value lost. Without the partnership with The Johnson & Johnson Family of Companies and access to their pre-clinical and clinical excellence, biomarker expertise and market knowledge, the RA Dendright project would have a lower

chance of success and benefiting patients. High-profile innovations such as Gardasil, Fibrotech and Spinifex Pharmaceuticals could not have been developed without a large multinational development partner with the necessary expertise. Consequently, Australia shares in the economic returns appropriately and can fund new research and initiatives like the new drug discovery initiative at UQ (Queensland Emory Drug Discovery Initiative or QEDDI) which is aimed at translating biological research into drug candidates that are available to be partnered for greater returns in order to retain more economic benefit to Australia.

University of South Australia — Mineral Flotation and Sustained Benefit for Mineral Processing

Summary

Collaborative investigation into the flotation of minerals has been a mainstay of UniSA research throughout its 25 year history. Now in its eighth phase of funding, the AMIRA P260 project is an exemplar of University/industry collaboration. Repeat business from major industry sponsors attests to the quality and relevance of the research outcomes.

The project was established to make significant contributions to the competitiveness of the mining industry globally through research, development and commercialisation and has delivered against this commitment. The focus on process improvements and new technologies to improve resource recovery for the industry have created in excess of $1 billion of economic value across the supply chain — in mining, chemical and engineering companies worldwide. The project has involved more than 100 mineral industry sponsors since 1988. The global reach of the collaboration ranges from multinational corporations to local SMEs.

AMIRA International Ltd — an independent association of minerals companies — has been a central partner to the program's development and success. AMIRA has highlighted that:

> this global program has demonstrated many successful research and technology transfer outcomes to the mineral industry in the area of flotation. This has in part been achieved through the development of tools and methodologies to improve the understanding of factors which control the separation efficiency of various mineral types and by training the flotation technologists of the future.[5]

Independent studies by RMDSTEM Ltd revealed more than $1 billion value added to the minerals industry over the programme lifetime. Industry partners secured a 22:1 return for every research dollar invested. The project has also produced 50 PhDs, the majority of whom now work in the mining and processing sector.

Key points

- A clearly defined industry challenge was established at the outset this was: to bring the cost of recovery down through improvements in floatation techniques, practices and processes that could be adopted across 30 identified mine sites across the world. The expectation that the research undertaken needed to be informed by this challenge and that any critical developments would be translated and commercialised, was clear from the start.

[5] http://www.amira.com.au/WEB/site.asp?section=projects&page=flagshipprojects

- A 30 year collaboration between the University[6] and private sector partners, brokered and managed via the Australian Mineral Industry Research Association (AMIRA). Evidence that the relationships were deepened over time resulting in increased funding commitments.
- Involving more than 30 mining, chemical and engineering companies worldwide, including major leaders BHP Billiton, Xstrata/Glencore, Vale, Rio Tinto, Anglo American, Cytec, Dow and Unilever underpinned by a multi-disciplinary approach to problem solving.
- Workforce impacts: the breakthroughs created through the program have informed the future, highly skilled workforce needs of the industry and resulted in 50 new jobs for PhD qualified staff.
- Public sector investment of almost $1 million from three consecutive ARC linkage grants was leveraged to attract over $27 million from industry partners.
- Leading to both incremental and step changes in processing performance, delivering benefits valued at $1 billion.
- Generating over 300 refereed publications (including conference papers) with in excess of 4000 citations to date.

Purpose of programme/project

A principal focus of the AMIRA P260 series of projects has been to develop tools and methodologies to improve understanding of factors which control the separation efficiency of minerals containing base metals in the flotation process. Importantly for sponsoring companies, the AMIRA P260 series of projects has addressed problems related to site and ore specific characteristics at over 30 different sites world-wide.

The process of froth flotation, whereby subtle control of mineral surface chemistry influences particle interaction with bubbles, has been the mainstay of mineral processing around the world for over a century. Each ore deposit has its own unique mineralogical context and requiring a different set of physical and chemical conditions for the optimal, selective beneficiation of the value mineral from the gangue, which is the commercially worthless material that surrounds it.

The programme objectives have included:

- Increase recovery of value minerals in coarse, composite particles in sponsor flotation plants and ores.
- Increase recovery of value minerals in fine particles in sponsor flotation plants and ores.
- Improve selectivity in sponsor flotation plants and ores by increasing rejection of gangue minerals, including minerals containing penalty element such arsenic, antimony, fluorine, mercury and bismuth in base metal concentrates.
- Increase recovery of gold in sponsor flotation plants and ores.

[6] The collaboration began even before UniSA was established in 1991. Commitments are in place to 2018.

- Assess the impact of reducing water consumption in flotation, and develop strategies to mitigate against negative impacts.
- Improve the concentrate quality of key non-base metal concentrates such as iron ore and phosphate concentrates with our research collaborators.
- Develop characterisation tools, methods and protocols for use by sponsors.
- Technology and information transfer to sponsors operations.

Collaborative approach

UniSA's minerals flotation programme has been described by AMIRA as one of the sector's "flagship" projects. The industry partners represent more than 30 mining, chemical and engineering companies worldwide, including major leaders BHP Billiton, Xstrata/Glencore, Vale, Rio Tinto, Anglo American, Cytec, Dow and Unilever.

Mt Isa Mines (part of Glencore Xstrata) has supported the programme for two substantial periods totalling 20 years since 1994. Belgian owned Maggotteaux Australia, an international supplier of grinding material, has committed uninterrupted support for 21 years from 1997 to 2018. Many of the partners of the AMIRA P260 programme have also engaged in other ways with the University's research base, through separately funded one-to-one projects and consultancies. In 2009, BHP Billiton invested $2.5 million into minerals research infrastructure at UniSA.

Throughout the programme, collaboration between the University and the minerals processing industry has maintained the following essential commitments:

Collaboration: Bringing together miners and supply/engineering companies, using new, supplier technology and chemical solutions to solve difficult and sometimes longstanding, problems.

***Lateral, multi-discplinary approach to problem solving*:** Pooling knowledge from Chemistry, chemical & process engineering, physics, mineralogy, and geochemistry to build fundamental knowledge of the flotation process.

Capacity building: Collaborative training of research-capable postgraduates in science and engineering disciplines. These PhD students work on a mix of fundamental and applied projects.

Professional, mutually beneficial relationships are sustained through regular contact between the research team and sponsor companies and particular efforts to maintain strong links at times when key staff change roles. Engagement includes regular visits by research staff and students to process operations and laboratories. One particularly successful element of the collaborative approach has been the University's multi-disciplinary team which enables us to understand industry needs across a range of perspectives. This level of understanding and commitment to long-term collaboration has provided our industry partners with the capability to work on issues they cannot solve alone.

Details and analysis of impact

The success and impact of the research is demonstrated by the project's longevity and repeat sponsorship throughout the eight phases of funding supported by AMIRA.

Impact has been made cumulatively over the project lifetime, by refining our understanding both of the science and engineering processes in play, and of the industry drivers and imperatives funding our work.

An independent study was conducted on the P260 project (1988 to 2006) by RMDSTEM Ltd[7], who engaged directly with the project sponsor companies. The report shows $318 million value add was delivered to the minerals industry, via successful technology transfer of research outputs, leading to measured, and verified commercial industry benefits.

Specific benefits to industry identified by the report included:

- Improving recovery;
- Increasing price realisation and avoiding penalties; and
- Reducing operating costs.

In addition to verified commercial industry benefits the report also identified $118 million in expected value, and $412 million in future opportunity value. A second RMDSTEM Ltd study[8], to assess the additional impact of the P260 Project on industry balance sheets from 2007 to 2012, demonstrated a further expected value of $155 million. Thus the total industry benefit of the P260 project exceeds $1 billion.

Additional academic achievements include:

- Over 300 refereed publications (including conference papers) with in excess of 4000 citations to date.
- More than 50 PhD students have graduated throughout the program, with the majority working in various parts of the sector.
- The project was evaluated as an outstanding case study in the ATN-Go8 Excellence in Innovation Australia Trial measure of impact. https://go8.edu.au/programs-and-fellowships/excellence-innovation-australia-eia-trial
- Three tranches of ARC Linkage funding (2006 – 2013) totalling $943,000.

[7] RMDSTEM Report. 'Evaluation of the AMIRA Project P260 over the period 1988 – 2006', Author Mai Landman, 21 August 2007.

[8] RMDSTEM Report. 'Estimation of the Value to Industry of the AMIRA International Project P260 for the Period 2007 to 2012', Author Paul Greenhill, 13 August 2012.

University of Southern Queensland — Regional Entrepreneurial Leadership, ecoBiz

Summary

ecoBiz is a business education and improvement program that assists Queensland small to medium enterprises (SMEs) develop eco-efficiency strategies for achieving resilience and competitive advantage. A partnership between the University of Southern Queensland (USQ), the Chamber of Commerce and Industry Queensland (CCIQ), the Queensland Government and Australian Business Training Solutions (ABTS) delivers ecoBiz as an innovative program involving knowledge dissemination, capacity building and performance benchmarking.

Launched in July 2013, this three year $3 million program has assisted SMEs to invest in the adoption of eco-efficiency initiatives to drive profitability and efficiency. The program encompasses technical content developed by university and industry specialists delivered through networking events, webinars, workshops, forums, innovative online tools, coaching and research. ecoBiz demonstrates the program utility of mutual reciprocity in framing inputs, as each partner has a strengths-based role and all roles integrate across the partnership with mutual benefits achieved.

Through its applied research agenda, USQ has developed partnerships with key industry and community stakeholders focused particularly on regional communities and economies. The partnership delivering the ecoBiz program exemplifies USQ's strategy and institutional support and it is a successful industry-university-government partnership, which utilises an integrated industry engagement model (see Figure 1).

Delivery of a business education and improvement program by a government-university-industry partnership is innovative in its complementary inputs framework, real time performance review and feedback, and platform for continuous improvement of the program based on participant experience. Delivered to a potential audience of 412,000 SMEs, ecoBiz utilises all the front end advantages of technology, targeted audiences, specialist knowledge and broad networks.

ecoBiz, having engaged hundreds of small businesses and using a model of integrated industry engagement to drive business innovation, can be directly replicated and offers a sustainable model for any industry-university-government partnership seeking to drive innovation in any industry. The model enables a combination of partners, who utilise eco-efficiency leaders, strive to identify best practice and use knowledge networks and diffusion. The model is scalable, entrepreneurial and impactful.

Purpose of program

The ecoBiz program was developed primarily to assist Queensland businesses to become more efficient and competitive. As resources such as energy, water, gas and material become more expensive, businesses need to reduce their resource consumption or find process efficiencies to save on input costs. Governments are also interested in reducing

resource use as it has environmental benefits of lowering carbon emissions, reduces the waste removal/management required of local councils and allows governments to direct water saved by businesses towards other beneficial uses, such as drinking water. Initial efforts to assist industry via the ecoBiz program were made by government through the Queensland Department of Environment Heritage's Sustainable Industries Division (2009-2012). In a strategic industry-university-government partnership, ecoBiz has been outsourced from government to the private sector to increase program innovation and provide more efficient cost effective delivery.

The advantages of the partnership approach are:

- greater engagement of businesses via their existing relationship with CCIQ;
- joint development of technical content for businesses by university adjunct industry fellows from USQ and industry training specialists from ABTS who are leaders in eco-efficiency;
- efficient transfer of insights from research to small businesses via online tools, face to face workshops and coaching; and
- greater diffusion of best practice amongst businesses by using the existing industry networks using networking events, webinars, workshops, Leaders Forums.

A recent report by the CCIQ found its members, who have access to the ecoBiz program, are now using their equipment to be more efficient and cost effective as well as investing in clean, green technology.

Summary of collaborative approach

The collaboration process began with the partners developing a joint proposal to deliver the ecoBiz program in 2012. The operating model they use demonstrates the utility of mutual reciprocity in framing inputs, delivery processes, expected outputs and outcomes. Each partner has a strengths-based role and each partner benefits from the other's strengths.

The government signed a lead contract agreeing to the funding and deliverables with CCIQ in 2013. USQ and ABTS each have separate contracts with CCIQ to deliver their components of the program. A board of external parties, including members of the Queensland Government, provides governance of the standard of delivery. Quarterly reports on deliverables are provided as per the contracted requirements.

Regular management meetings are held between executives of USQ and the CEO of CCIQ. Day to day delivery arrangements are made amongst the staff of CCIQ, USQ and ABTS. Workshops and meetings of the staff are also used to expedite improvements or deal with any issues that arise.

Analysis of collaborative approach

The major reasons the collaboration is a success are because the goals of the program and organisations involved are complementary. Good business practices promoted by ABTS and CCIQ include eco-efficiency while eco-efficiency promoted by USQ as part of the ecoBiz program encourages business efficiency.

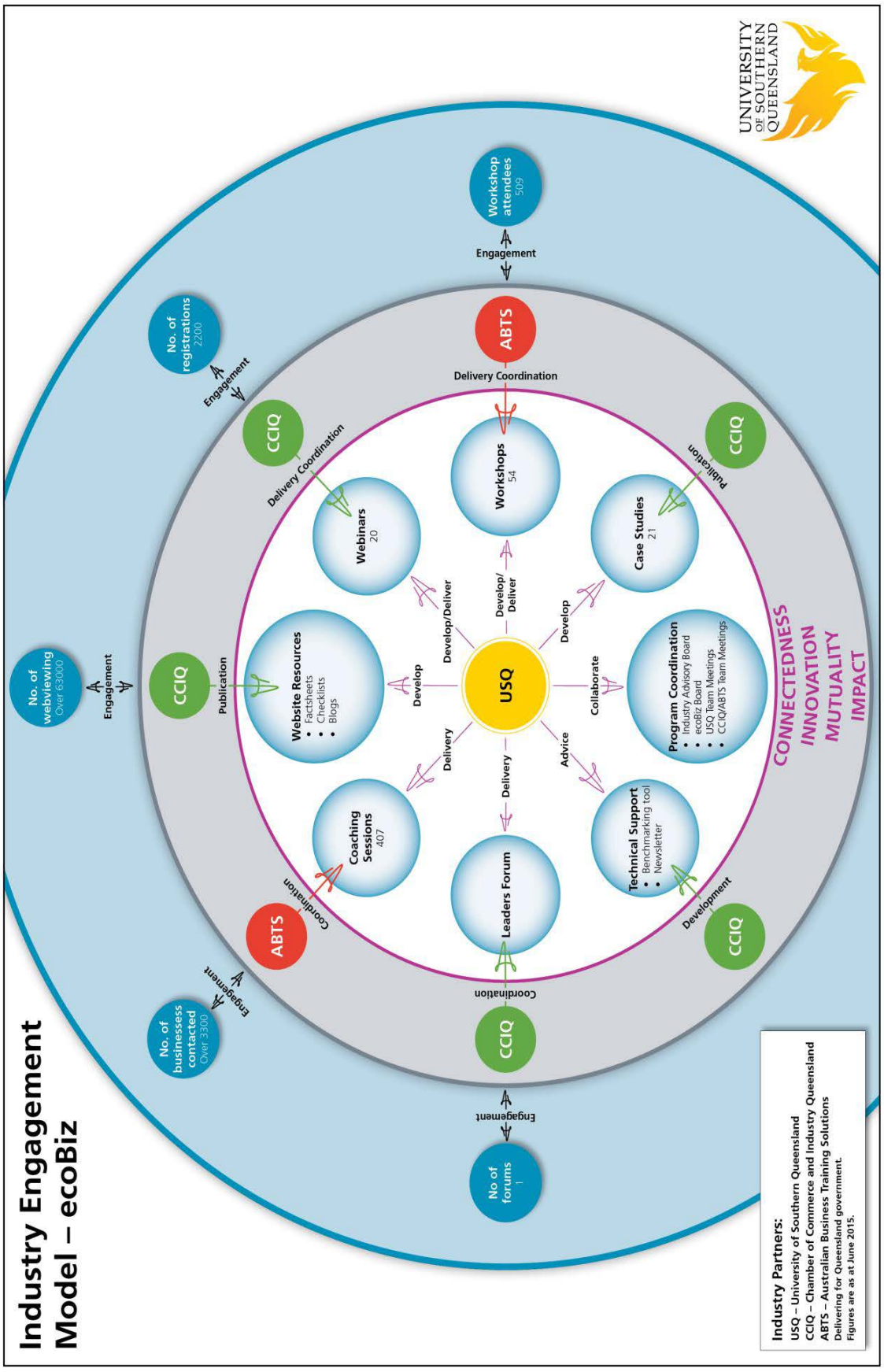
The mutual desire of all partners to access the same target audience is another factor in the program's success. For example, businesses may become aware of courses with ABTS, being a member of CCIQ, or receiving the free information resources of USQ. By jointly promoting their services, each organisation has more opportunity of a business knowing about their particular services. A shared understanding of the mutual interests and organisational drivers has ensured good working relationships amongst the parties.

The key to successful delivery has been the effective integration of systems and process. USQ develops the program content and design and manages program evaluation and improvement. CCIQ's marketing expertise and training facilities utilises well-established social media channels along with its network of chambers of commerce to ensure state-wide business engagement with the program. ABTS, as a training organisation, facilitates industry members to learn how to drive cultural and practical changes to realise greater efficiency in their businesses.

The program has made contact with over 63,000 web viewers, 2,200 registrations and 509 workshop attendees and has developed 21 case studies and run 407 coaching sessions. While the ecoBiz program has a robust program design, the delivery is improved upon with regular feedback. For example USQ and ABTS have improved planning of coaching sessions, and USQ and CCIQ staff have worked to improve the business monitoring and information management tools used by participants in the ecoBiz program. A full program evaluation is being conducted to inform a refined model of program delivery in 2016 – 2019.

The ecoBiz program can thus be regarded as a 'real world working laboratory', which fosters long term industry-government-university research partnerships and provides a fertile ground for future research, deeper member- industry engagement and training and development opportunities.

Figure 1. Industry Engagement Model — ecoBiz



University of Sydney — The Rio Tinto Centre for Mine Automation (RTCMA)

Partners or end-users: Rio Tinto, through its subsidiary Technological Resources Pty Ltd

Sector: Rio Tinto is a publicly-traded company in the resource sector

Sources of Support: Monetary payments and in kind contributions.

- Rio Tinto funds the centre and seconds engineers into the Centre for a variety of periods
- The University makes contributions through
    - the provision of key researchers (0.2 FTE for the lead researcher Professor Salah Sukkarieh)
    - administrative support (0.4FTE)
    - access to equipment and facilities of significant value

Purpose of programme/project

What was the problem or issue being addressed?

Rio Tinto is seeking step changes in safety, predictability, precision and efficiency for its mining operations, through the research, development and instantiation of autonomous systems.

Was there a particular solution to be achieved?

The aim of RTCMA is to facilitate the development and implementation of the vision of a fully autonomous, remotely operated mine, by undertaking research in autonomous systems relevant to Rio Tinto operations.

Summary of collaborative approach

What was the nature of the partnership/collaboration?

Rio Tinto is funding a significant and continuing program of research and development work at the University of Sydney. To date the Centre has engaged 31 researchers, 50 engineers and 19 PhD students for participation in various stages of the programme.

Was there a pre-existing partnership? How long has it been in effect?

Yes, Professor Hugh Durrant-Whyte, then Research Director of the Australian Centre for Field Robotics (ACFR) at the University, had a pre-existing relationship with Rio Tinto which began in 2000. Prior work undertaken by Professors Salah Sukkarieh (current Research Director at ACFR) and Eduardo Nebot (current Centre Director at ACFR) was also essential in fostering the collaboration. The relationship grew through the delivery of a number of collaborative research and student projects with other researchers in the ACFR as part of CRC Mining. In 2007 Rio Tinto approached the University of Sydney directly to undertake a

joint collaborative research project through RTCMA. The proposal was developed jointly by Durrant-Whyte, Sukkarieh and Nebot.

The Centre started in 2007 with a significant five-year initial commitment. The Centre was renewed in 2012 and again in 2014, this time for a further five years to 2019 (a 12 year commitment so far).

What were the mechanisms employed to implement and manage the collaborative processes?

The Centre was designed with a combination of appropriate governance and organisational structure, supported by ICT platforms and tools to encourage regular seamless interaction between university researchers and Rio Tinto engineers. The Centre employs a full time Director to support the research and development pipeline and help transition the research through to Rio Tinto. The Centre exists within the ACFR structure and thus enjoys the research and organisational processes employed, and the ACFR research director maintains an overall research governance view of RTCMA.

Analysis of collaborative approach

What were the contributions of each party? Were they appropriate and effective?

The University focused on research directed to the development of autonomous platforms, algorithms and software that supported Rio Tinto operations.

Rio Tinto provides feedback on the research as the algorithms and software took shape and also provided background information and experience regarding operation priorities. The background information was essential to provide the real world constraints that the researchers needed to consider in researching and developing the autonomous systems

What specific steps or activities were taken to support/achieve mutual interests and benefits, due to the different organisational drivers?

The high level steering group governs overall project direction, informed by the project review committee. Both groups have representation from Rio Tinto and the University, to ensure alignment at operational and strategic levels. For the University, the Dean of the Faculty of Engineering and IT sits on the steering group and the Centre director and lead researcher sit on the project review committee.

What was most successful element of the collaborative approach?

There is a very strong desire by both parties to ensure that the work undertaken has successful outcomes for all. This translates to a very high level of collegiate engagement and commitment to the work from both parties. Processes have been put in place that support this culture, rather than trying to enforce such behaviour.

What lessons were learnt for future/ongoing collaboration?

Such a large collaboration needs buy-in and engagement from both parties at all levels of the R&D pipeline, from the company and university leadership teams down through both organisations.

There needs to be a clear mutual understanding to the role the University will play, i.e. what is appropriate for the University to be undertaking, how far will its work extend and at what point a formal handover should be undertaken. This is essential for ensure a smooth transition of research outputs into the company.

The detailed design of the systems to support the above processes is completely dependent on the work undertaken and therefore unique to each collaboration — a one-size-fits-all process/procedure does not work.

Details and analysis of impact

How well did the programme/project achieve its objectives?

There has been commitment now for 12 years. Rio Tinto continuously evaluates the value being generated from all of its relationships with external partners. Rio Tinto's ongoing commitment to funding RTCMA indicates that it continues to see value in the work being undertaken.

What has been the impact of the programme/project (social, economic, commercial, community and/or other impacts)?

Analytics work (proxy hardness measures from drilling data) has contributed to the reclassification of a significant volume of mined material, which has had a direct economic impact on the business.

The autonomous drill project, begun at University of Sydney and productised at Rio Tinto, has already shown utilisation improvements, compared to the manned fleet. The West Angelas mine in the Pilbara, West Australia, is now the world's first fully autonomous drill mine, with seven rigs in operation that have now drilled over two million metres.

Rio Tinto has recently announced that the Mine Automation System (MAS) and the RTVis™ visualisation software is now in operation at all of its Pilbara minesites and is being progressively rolled out across its Copper, Coal and Minerals businesses. Many of the core concepts used in these systems were developed under the RTCMA programme.

How do or did you measure/evaluate the programme's impact? What was the time frame?

On the practical level the algorithms and software is directly compared to current system implementations. On the programme level the impact can be measured by the fact the system is transforming internal business operations and the level of support of upper management.

Is there likely to be on-going impact?

Yes, ongoing benefits to Rio Tinto for gains in efficiency and other areas are expected.

Have there been any evaluations and/or follow up studies of the programme/project?

[as above] Yes, Rio Tinto continuously evaluates the value being generated from all of its relationships with external partners. Rio Tinto's ongoing commitment to funding RTCMA indicates that value is continuing to be created.

Is there any specific data or other evidence of academic or other impact (e.g. citations, patents, start-ups, ongoing or long-term collaboration arising from the programme/project)?

Yes, 166 research publications and 22 patent families have been published on the research and technology advances made in the Centre, ranging from autonomous drill systems to clearer data models built from complex datasets.

Depth of collaboration is illustrated by the statistics that five of the papers included authors from Rio Tinto and four of the patent families included Rio Tinto inventors.

How did the collaborative approach contribute to the impact?

A collaborative approach has reduced project lifecycle duration from initial concept through to project delivery. Also, the collaborative approach has contributed to an improved technology uptake, increasing the number of instances of operational deployment.

University of Sydney — Treating Inoperable Cancer Using Novel Small Particle Technology

Partners or end-users: Sirtex.

Sector: Private industry — Global life-sciences company that develops and delivers effective oncology treatments using novel small particle technology.

Sources of support:

- Partner funding and in-kind contributions, ARC Linkage projects and AusIndustry Research Connections scheme.
- Most collaborative work at the Key Centre for and Colloids (KCPC) is funded by Sirtex.
- The University has also been awarded several grants under the Australian Research Council's Linkage Project Scheme, including $525,000 to work a project that was aimed at targeted hyperthermia treatment for liver cancer.
- AusIndustry Research Connections scheme assisted with establishment of the relations that were the foundation for a successful ARC Linkage application.

Purpose of programme/project

What was the problem or issue being addressed?

Sirtex is an Australian-based global life-sciences public company, providing a radioactive treatment called SIR-Spheres microspheres for inoperable liver and colorectal cancers.

- Primary liver cancer, or hepatocellular carcinoma (HCC), is responsible for about 90 per cent of the primary malignant liver tumours in adults and the incidence is increasing due to increased rates of chronic infection with Hepatitis B and Hepatitis C in Asia.
- Colorectal cancer (CRC) is the third leading cause of cancer-related death in the western world. An estimated 1.6 million people are diagnosed with the disease worldwide every year, and around 37.5 per cent of these have, or will develop, inoperable liver metastases requiring non-surgical treatment, namely chemotherapy and other technologies including SIR-Spheres microspheres.

Was there a particular solution to be achieved?

Sirtex's SIR-Spheres technology treats liver cancer through Selective Internal Radiation Therapy (SIRT), where very small radioactive beads about one third the width of a human hair are injected into tumours within the liver to deliver radiation over 11 days. This procedure enables high doses of radiation to be targeted to liver tumours via the hepatic artery, minimising exposure to the remaining healthy liver tissue, maximising the number of microspheres delivered, and optimising tumour coverage, even in patients with extensive disease — an improvement over chemotherapy.

Summary of the Collaborative Approach

What is the nature of the partnership/collaboration?

The University of Sydney has a long-standing research collaboration with Sirtex in polymer science and radiation therapy.

Was there a pre-existing partnership? How long has it been in effect?

This project is part of a partnership spanning 14 years. A/Prof Brian Hawkett from the University's Key Centre for Polymers and Colloids (KCPC) initially exchanged confidential agreements with Sirtex in 2001, and began collaborating in 2003.

What were the mechanisms employed to implement and manage the collaborative process.

A/Prof Hawkett, Director of KCPC, has a distinguished career in both academia and industry, including experiences as research manager in Berger and British Paints and ICI Specialty Chemicals. His previous experience has assisted build strong working relationship with Sirtex based on trust, mutual understanding, unrestricted learning, and inter-organisational knowledge-sharing to achieve a high level of joint decision making at both strategic and operational levels. Excellent personal communication and confidence between the researchers and the partner organisation means there is no need for a high-level management committee or strict processes which can add to the administrative burden on both sides.

Professor Dale Bailey and Professor Zdenka Kuncic attracted ARC Linkage Project funding to use basic physics and radiobiology knowledge of the effects of ionising radiation on living cells to examine the clinical outcome for different radiation dose distributions. The project eschewed traditional in vitro approaches to predicting cellular response to radiation (with difficult to quantify phenomena such as bystander effects) by translating it into radiation-dose response relationships at the level of the whole organ and human. The results will have direct impact on the basic science of targeted cancer therapeutics using internal administered irradiation.

Professor Bailey took advantage of the AusIndustry Research Connections scheme to facilitate meetings with Sirtex, and provided funding on grants that allowed Sirtex access to expertise at the University of Sydney and build pilot data towards the successful Linkage Project application. Following the conclusion of the Linkage Project, Sirtex continued to provide funding to the same team to explore a theranostics approach for the treatment of liver cancer, which incorporates radiobiology into personalised radioembolisation therapy.

Analysis of collaborative approach

What were the contributions of each party? Were they appropriate and effective?

Sirtex has a small Sydney-based team of research and development personnel. A/Prof Hawkett and Sirtex, including its global head of research and development Dr Steve Jones, are in constant contact. This provides transparency to the partner organisation on the

project, and enables the University research team to obtain immediate feedback on the commercial potential of discoveries within the laboratory. Sirtex-run clinical trials on their product inform A/Prof Hawkett's team, which has the chemical expertise to tailor nanoparticles to maximise the efficacy of the therapeutics. The feedback loop on technical development and commercial potential has created a collaborative culture between the two institutions, which in turn shaped a commitment to deliver on-going clinical, economic and academic impact.

What steps or activities were taken to support/achieve mutual interests and benefits?

See above.

What was the most successful element of the collaborative approach?

The interpersonal and interorganisational trust between Sirtex and the University is indispensable to the on-going collaboration, and facilitates contract negotiations between partners and the establishment of new strategic initiatives.

What lessons were learnt for future/ongoing collaboration?

The relationships between the multiple distinct groups in the University of Sydney with Sirtex have started with small projects that serve as a trial phase. Initial alliances among previously inexperienced partners often begin with formal contractual linkages that expose the partners only to small risks, for example government funding through AusIndustry Research Connections and ARC Linkage Project Schemes.

As the relationships solidified over time and partners gain trust and understanding of implicit/explicit rules and procedures, and clear expectations of personnel in both companies, they rely less on formal contractual linkages and increasingly informal operational, strategic and social mechanisms govern their collaboration.

In this case, mutual trust paired with strong communication channels between partners has enabled a virtuous cycle where research influences products and clinical trials inform ongoing research. Sirtex personnel engage with and inform research projects conducted at the University, and this collaborative engagement, in addition to the financial contribution, ensures that projects are relevant to the commercialisation of the intellectual property for economic and societal benefits.

Details and analysis of impact

How well did the programme achieve its objectives?

Very well.

What has been the impact of the programme/project (social, economic, commercial, community and/or other impacts)? How do or did you measure/evaluate the programme's impact? What was the time frame? Is there likely to be ongoing impact?

Yes. The collaboration with Sirtex is ongoing and generating stimulating science and ever more exciting applications.

Economic Impact: In 2015, Sirtex reported dose sales of SIR-Spheres microspheres grew more than 100 per cent since 2011 with more than 10,252 doses being supplied for the year ending June 30, 2015. Globally, revenue was $176 million Australian dollars, up 36 per cent from 2014, with net profit after tax of AU$40 million.

Sirtex also grew its workforce by 15 per cent in the year ending June 30, 2015 to a total of 246, with 35 per cent being based in the Asia Pacific region. Sydney remains the corporate headquarters of the company despite its strong growth globally, with the leadership team being based here.

Academic/Training Impact: The close relationship between Sirtex and the University of Sydney supports world-class research and development and the training of new researchers in the fields of polymer science and radiation therapy.

Clinical Impact: Results from the largest most comprehensive study to date evaluating SIRT in liver metastases from colorectal cancer have demonstrated safety and efficacy in treating the elderly. The results from the SIRFLOX studies (the largest randomized interventional radiology study ever conducted in oncology) have been well accepted by the medical oncology community. The feedback from Key Opinion Leaders (KOLs) has been positive.

Sirtex anticipates increased utilisation of SIR-Sphere Y-90 resin microspheres in the first-line setting will gain momentum over time. SIRFLOX is the first ever study with Level 1 evidence to show a liver-directed therapy in combination with systemic chemotherapy and a biologic agent produces a clinically meaningful and significant effect in the liver. Consequently, incorporation into clinical practice beyond the current salvage setting in mCRC is now a realistic possibility with continued education of the results to the medical oncology community.

With a 7.9 month improvement in Progression-Free Survival (PFS), a 31 per cent lower risk of progression (HR=0.69) and strong statistical significance (p=0.002) achieved in the liver, this finding is important because the liver is almost invariably the organ where colorectal cancer spreads to first.

Is there any specific data or other evidence of academic or other impact (e.g., patents, start-ups, on-going of long-term collaboration arising from the programme/project)?

A/Prof Hawkett's team's research has resulted in the following patent filings (and the applications that claim priorities from these filings):

1. Administrable Compositions (AU2008902429);
2. Polymer Microgel Beads (AU2008902428);
3. Polymer Microgel Beads and Preparative Method Thereof (AU2008902430); and
4. A Method of Treatment and Agents Useful for Same (AU2012900480).

University of Technology Sydney — Elemental Bio-imaging Facility (EBF)

Partners or end-users: Agilent Technologies

Sector: Private industry

Sources of Support: EBF has received strategic investment by UTS and in addition, since 2010 the centre has received major cash and in-kind support from industry exceeding $2 million, as well as four ARC Linkage Project Grants and significant competitive state government funding.

Purpose of programme/project

The Elemental Bio-imaging Facility was established to develop new and innovative applications for bio-imaging instrumentation to enable researchers and industry worldwide to analyse elements in new ways.

The collaboration pushes the capabilities of current technologies to develop ground breaking improvements in bio-imaging instrumentation, methods and applications for solving complex analytical and biological research questions.

Examples include:

- Using pioneering methods developed in-house, the EBF team were the first to report a three dimensional elemental reconstruction of the brain of a Parkinson's disease mouse model, which will provide the basis for ongoing research into neurogenerative diseases such as Parkinson's and Alzheimer's disease, and inform development of novel therapeutic interventions.
- Using liquid and gas chromomatography mass spectrometry, inductively coupled laser mass spectrometry, and next sequencing technologies EBF researchers performed the first paleo-multiomics study on Ötzi, the world's oldest ice mummy. This included genomics, proteomics, glycomics, metabolomics, lipidomics and metallomics approaches, yielding insights into his diet and health conditions.
- Applying novel methods to models of marine pollution to quantify the levels of metallic and nanoparticle pollutants that partition from the environment to the food chain and understand why they accumulate in specific organs.

Summary of collaborative approach

What was the nature of the partnership/collaboration?

UTS provides the facility and scientific staff to perform the research. Agilent Technologies supply equipment, funding for project work, scholarships for postgraduate students to pursue research in this area, technical consulting, grants to develop imaging technology, and they facilitate productive opportunities for EBF researchers to interact and collaborate with researchers across Australia and around the globe.

Was there a pre-existing partnership? How long has it been in effect?

The partnership has been in effect since 2002, and the Agilent-sponsored UTS Elemental Bio-imaging Facility opened in 2007.

What were the mechanisms employed to implement and manage the collaborative processes?

EBF Director, Professor Philip Doble identifies the main mechanisms for managing the collaborative process as communication and building strong professional relationships.

Professor Doble spent many years getting to know the people from Agilent Technologies, and continues to routinely talk to them, attend conferences and seminars, as well as giving seminars for Agilent. As a result of this relationship-building and mutual area of research interest, collaborations and mechanisms for those collaborations have evolved naturally.

Analysis of collaborative approach

What were the contributions of each party? Were they appropriate and effective?

Agilent supplies state-of-the-art equipment necessary to EBF research, which EBF researchers would otherwise not have access to, and actively fosters international connections across academia and industry via their client base, facilitating knowledge-sharing and initiating productive partnerships that further EBF research. UTS provides the research expertise to utilise the technology in novel ways, which has resulted in new applications and imaging techniques.

The partnership and respective contributions of the collaborators have been highly effective, with results including significant advances in Parkinson's, Alzheimer's and arthritis research; quantitative analysis of accumulation of environmental contaminants in marine organisms; 2D and 3D spatial localisation and quantitation of specific proteins, sugars and prosthetic groups within tissues in health and disease; and archaeological applications that have provided unique insights into social aspects of human evolution via determination of the nutritional status of hominid remains.

What specific steps or activities were taken to support/achieve mutual interests and benefits, due to the different organisational drivers?

From the beginning of the partnership, the goals and interests established were mutually beneficial.

The research EBF are doing delivers new applications for Agilent Technologies, and having access to Agilent equipment allows EBF to break new ground in their research. In addition, Agilent Technologies actively facilitates EBF research by identifying and enabling potential third-party collaborations worldwide. Agilent are also able to utilise the facilities at UTS as a demonstration lab for clients.

Since both parties derive direct and complementary benefits from the collaboration, the primary mechanism for ensuring the interests of both parties continue to be met is ongoing communication.

When Agilent Technologies develop a new piece of equipment, they consult with EBF to test its potential applications. EBF researchers experiment with the equipment, often in collaboration with researchers identified by Agilent Technologies as having needs that could potentially be met using the equipment. EBF continues to liaise closely with Agilent in producing papers and developing new applications that assist Agilent to improve upon and market their technologies.

What was most successful element of the collaborative approach?

EBF has had four successful Linkage Grants with Agilent Technologies, and published more than 50 research papers in the past five years using Agilent equipment and working with collaborative partners introduced by Agilent. This includes publication in top-ranked journals such as Nature, Neuroscience, Analytical Chemistry and Metallomics.

Professor Doble observes that these achievements were only made possible by the collaboration with Agilent Technologies.

The collaboration has also resulted in many successes not taken into account by traditional metrics: the additional credibility that being endorsed by a major vendor endows, additional possibilities for professional development of students and postdocs, access to equipment that would not be possible without industry support, and exposure to a broad base of researchers and industry professionals who have an interest in the work EBF is doing and willing to assist or collaborate.

What lessons were learnt for future/ongoing collaboration?

Professor Doble notes that as a researcher, in order to establish a successful industry partnership, it's important to make the partner feel welcome and simplify administration, which can be an obstacle both from within the university and from within the organisation. Finding the champions within the company and the university who can negotiate the administrative hurdles can allow the collaboration to meet its potential.

In such a competitive environment, the ability to handle rejection and criticism is important, including the ability to take an initial negative response as an opportunity to initiate negotiations.

For example, requesting significant cash contributions from industry partners for ARC linkage programs is usually met with reluctance, non-specific promises of support and often left to a future date for commitment. Useful strategies to ensure commitment are:

1. Identify the commercial needs of the partner and address them in the LP proposal
2. List the benefits of the LP from a scientific benefit perspective and discuss the commercial benefits of corporate citizenship. Companies are often open to giving cash if it benefits their corporate profile, especially among their customers and shareholders

3. Ensure that you are able to talk with the decision-maker – your champion within the organisation should be able to enable this.

Details and analysis of impact

How well did the programme/project achieve its objectives?

EBF is the only dedicated facility in the world for imaging trace elements by laser ablation inductively coupled plasma mass spectrometry. The EBF team has continuously broken new ground in research and the development of innovative analysis solutions to meet the needs of collaborators, clients and industry partners. In the field of analytical chemistry, EBF research has been instrumental in changing what can be achieved by in situ elemental analysis in biological samples.

What has been the impact of the programme/project (social, economic, commercial, community and/or other impacts)?

The collaboration has resulted in a universal imaging system that can measure elements and metals in biological systems in unique ways; allowing quantifiable measurements at the micron level. Its application has had wide-ranging impacts for researchers and for society, including:

- Parkinson's disease — the EBF team were the first to show that iron can form a redox coupling with dopamine releasing free radicals, and to compartmentalise it into specific neuro-anatomical regions, enabling effective investigation of therapeutic interventions.
- A world-first demonstration of major dietary shifts (such as length of breastfeeding and time of weaning) in fossilised primate teeth determined by analysis of the distributions of specific elements. This was will have a significant impact on anthropological and evolutionary studies of human populations and their nutritional status.
- The application of these techniques to imaging elements to distinguish metastases in lymph nodes, which have provided new tools for the in situ analysis of elements in biological materials. This is a significant advance on traditional histological stains or analyses of digested tissue, and was featured as a major innovation in the Royal Society of Chemistry Chemical biology news and research.

The techniques developed by EBF will continue to allow revelation of previously latent information and provide analytical solutions for a wide variety of current and future biological problems.

How do or did you measure/evaluate the programme's impact? What was the time frame?

In terms of traditional metrics, EBF research has published more than 50 papers in the last five years, including publication in top-ranked journals such as *Nature*, *Neuroscience*, *Analytical Chemistry* and *Metallomics*, and garnered $2 million in industry funding, as well as four ARC Linkage Grants.

Other measures include the continuing generation of third party collaborations to facilitate the research of other institutions, including an ongoing collaboration with the Florey Institute, and current partnerships with Monash University to examine the metabolism of cancers; the University of Sydney to examine chemotherapeutic efficacy; and Cambridge University to examine changing metal profiles in human brains from foetus through to old age.

The program has also trained 10 PhD students, including Dominic Hare who has gone on to secure an adjunct position at the prestigious Icahn School of Medicine at Mount Sinai in New York, and a secondment to the Florey Institute of Neuroscience and Mental Health in Melbourne to further his research into Parkinson's disease.

Is there likely to be on-going impact?

The ongoing impact is threefold: 1. directly through new research and research collaborations that continue to develop as a result of the EBF/Agilent technologies collaboration, 2. through the possibilities enabled by pioneering techniques developed within EBF, and 3. through the development of researcher skills.

1. EBF conducts elemental analysis and molecular mass spectrometry, and is a resource to researchers and students at UTS, as well as researchers from other local and international institutions. EBF has an ongoing collaboration with the Florey Institute, is currently working with Monash University examining metabolism of cancers; the University of Sydney examining chemotherapeutic efficacy; Macquarie University examining the role of metals in neurodegenerative disorders; Monash University looking at data fusion techniques for infrared spectroscopy, EBI and Immunohistochemical micrographs for multiple sclerosis; Seoul University Hospital looking at MRI contrasting agents such as gadolinium, and a consortium of researchers from 1. UC Davis, Davis, USA; 2. Chungnam National University, Daejeon, South-Korea; 3. ISB, Seattle, USA; 4. University of Technology Sydney, Australia, 5. National University of Singapore, Singapore, and 6. EURAC Institute for Mummies and the Iceman, Bolzano, where EBI has contributed to an 'omic' study of the Oetzi the world's oldest preserved mummy.
2. One of EBF's major achievements has been the development of a new technique for imaging biological samples, which has opened up possibilities in the field of metallomics for researchers to probe many different diseases including Parkinson's disease, Alzheimer's disease and Multiple Sclerosis.
3. Through the EBF, local researchers are able to develop a set of skills that are otherwise hard to come by: learning how to run a mass spectrometer, lasers and interfacing, data processing and troubleshooting using this equipment to generate high quality data. Developing these skills takes years of training, and would not be possible without access to very expensive equipment, which the collaboration with Agilent Technologies enables.

Have there been any evaluations and/or follow up studies of the programme/project?

The success of the program has been evaluated in terms of its extensive and ongoing impact, detailed above: the development of pioneering techniques in laser ablation

inductively coupled plasma mass spectrometry; successful application of these techniques to a diverse range of investigations including research into neuro-degenerative diseases, dietary biomarkers and environmental contaminants; the publication of 50-plus research papers in the past five years, including publication in top-ranked journals; and successfully securing four ARC Linkage Project Grants and significant competitive state government funding, as well as cash and in-kind support from industry exceeding $2 million.

Is there any specific data or other evidence of academic or other impact (e.g. citations, patents, start-ups, ongoing or long-term collaboration arising from the programme/project)?

Highlights of academic impact:

- Barium distributions in teeth reveal early-life dietary transitions in primates, *Nature* 498, 216–219 (13 June 2013)
- Quantitative elemental bio-imaging of Mn, Fe, Cu and Zn in 6-hydroxydopamine Parkinsonism mouse models, *Metallomics* (2009) 1, 53-58
    - in January 2012 this paper was one of the 10 most cited articles in the history of *Metallomics*.
- Three dimensional elemental bio-imaging of Fe, Zn, Cu, Mn and P in a 6-hydroxydopamine lesioned mouse brain, *Metallomics* (2010) 2, 745-753, and Three-dimensional atlas of iron, copper, and zinc in the mouse cerebrum and brainstem, *Analytical Chemistry* (2012), 84 3990-3997
    - These two papers describe the first three-dimensional reconstruction of metals in the mouse brain, and led to ARC funding
- Elemental bio-imaging of melanoma in lymph node biopsies, *The Analyst* (2009) 134, 450-453
    - This is the first report of imaging methods for trace elements in metastatic melanoma
- Elemental bioimaging of thorium, uranium and plutonium in tissues from occupationally exposed former nuclear workers, *Analytical Chemistry* (2010) 82, 3176-3182
    - This paper described the first ever imaging of plutonium in the tissue of former nuclear workers
- Elemental bio-imaging of calcium phosphate crystal deposits in knee samples from arthritic patients, *Metallomics* (2009) 1, 142-147
    - This article appeared on the front cover of Metallomics

Most cited publications:

- Quantitative elemental bio-imaging of Mn, Fe, Cu and Zn in 6-hydroxydopamine Parkinsonism mouse models, *Metallomics* (2009) 1, 53-58
    - Citations 54 (Web of Science)
- Quantification strategies for elemental imaging of biological samples using laser ablation-inductively coupled plasma-mass spectrometry, *Analyst* (2012) 137(7), 1527-1537
    - Citations 42 (WoS)

- Quantification method for elemental bio-imaging by LA-ICP-MS using metal spiked PMMA films, *Journal of Analytical Atomic Spectrometry*, 25(5),722-725 (Jan 2010)
    - Citations 28 (WoS)

How did the collaborative approach contribute to the impact?

The collaboration between Agilent Technologies and UTS researchers is critical to the existence and everyday operation of the Elemental Bio-imaging Facility and its research. Without Agilent's collaboration such an extensive range of specialised equipment would not be available within EBF. In addition, many of EBF's collaborations with researchers from other local and international universities, and their subsequent research developments, might not have arisen without Agilent's active facilitation.

For example, Agilent Technologies facilitated professional introductions that resulted in EBF's involvement in the international research consortium that has produced complex insights into the life of Oetzi, the world's oldest completely preserved human ice mummy.

University of the Sunshine Coast — Australian Forest Operations Research Alliance (AFORA)

Sector: Australian forest growing/management industry

Sources of Support: Direct industry cash and in-kind contribution to a collaborative RD&E program. Where priorities of AFORA aligned with competitive grant opportunities AFORA investment was leveraged with competitive grants targeted at applied industry research; particularly from Forest and Wood Products Australia

Purpose of programme/project

A collaborative approach to retain and build on the momentum of research in Australian forest supply operations based at USC. The research program objectives are:

- understanding, managing and controlling operational costs for existing, evolving and new harvest systems
- planning and managing value recovery within harvest operations
- optimising system and supply chain efficiency.

Summary of collaborative approach

Industry partners make an annual cash contribution that are pooled from all the partners to make the RD&E budget. The industry partners are made up of forest growers and related industry stakeholders (industry associations, timber processors and other end-users of wood). The participating forest growers represent approximately 80 per cent of the forest growing industry in Australia.

AFORA was established out of a CRC for Forestry harvesting and operations research program that had run for 5-years before AFORA was established. As the CRC for Forestry wrapped up AFORA was established by the industry partners, most of which were CRC for Forestry members, with USC. AFORA has now run for just over 3 years and has just been re-signed for an additional 3 years in the past month.

AFORA has two meetings per year of a management committee that includes a representative from each partner. One meeting per year is designed as an update on project progress and allow the management committee to provide input to the overall direction of current and planned RD&E activities within AFORA. The second meeting per year included a briefer update of project progress with more time allocated to defining new projects of potential interest to industry. These new projects along with the current list of active and planned projects is circulated to the management committee with a brief project description, indicative budget and assessment of risk/impact so that each member can prioritise those project of the most importance to their company. The individual priorities are then compiled to produce a project priority list for AFORA going forward. If an active project falls in priority it will be scaled back and run to a reasonable conclusion. Projects that become active are guided by the priority list but what projects actually become active is also

dependant on the skills and resources available, industry in-kind support of appropriate study sites, outside funding leverage opportunities and outside collaboration opportunities.

Analysis of collaborative approach

Each partner made a cash and in-kind contribution relative to the size of their business and potential to be engaged with AFORA. The Cash budget from 15 to 18 partners was about $200,000 per year with approximately 2 to 3 times that amount provided as in-kind industry time, access to operations/sites and background IP. Funding leverage opportunities with related grates typically added $75,000 to $125,000 to the budget each year. This is about 35 per cent to 40 per cent of the budget available to similar RD&E objectives during the CRC for Forestry funding and forms of government matching support would be valuable to bring the RD&E activity up to an appropriate level

The program has allowed the maintenance of a critical mass in the area of forestry supply chain RD&E in Australia that has provided a range of outputs and outcomes that have had impact with the industry partners. It has also created a strong connection point in Australia for international collaboration on forestry and woody biomass supply chain research, with AFORA being recognised internationally as a leader in the RD&E space.

In addition to developing priorities for the group and driving RD&E activity towards the group priorities there needs to be mechanisms and pathways for individual partners or sub-groups with in AFORA to have specific priorities address. With the current renewal of AFORA new project establishment mechanisms have been put in place to allow partners to direct investment to particular priorities.

Details and analysis of impact

The program has met its objectives and strong indication of its success is the ongoing support of industry partners to renew the program. The initial program was 12 months, the first renewal was for an additional two years and the most recent renewal has been for three more years.

The program has produced or developed in excess of 16 industry reports that detail project outcomes and points of interest for application of the results, 5 industry models/tools to support supply chain planning and management and a number of industry targeted workshops and presentations in Australia. Examples of outcomes:

- introduction of Fast Truck forest transportation planning tool offers transportation solutions that reduce transport cost by 10 per cent saving industry up to $2 million per year
- developed improved application of product selection optimisation when harvesting trees reduces costs by 7 per cent and increased value by 2 per cent benefitting industry over $5 million per year
- development of the machine/harvest system selection tool – Australian Logging Productivity and Cost Assessment (ALPACA) allows industry to better select harvesting technology that reduces costs by up to 15 per cent saving industry over $5 million per year.

In the last three years the AFORA has acted as the contact point for more than 6 key international collaborations including leadership roles in a number of European based RD&E networks (FP7, COST Action, IEA-Bioenergy, etc.)

Measurement and evaluation of progress/success was done through ongoing communication with the industry partners and identifying where within their operations RD&E outcomes were being applied and used self-assessment by the partners as to the impact they appeared to have.

As solutions applied to ongoing operations, AFORA outputs and outcomes are well placed to have ongoing impact within the industry. In some cases, leveraging off the international partnerships fostered by the AFORA program these impacts are going beyond Australian industry.

As a currently active program there is regular reflection within the management committee on progress and opportunities to improve.

University of Wollongong — ARC Research Hub for Australian Steel Manufacturing (Steel Research Hub)

Partners or end-users: Australian Steel Industry

Sector (e.g. government department, private industry): Private Industry

Sources of Support: Australian Research Council (ARC) Industrial Transformation Research Programme, Industry Partners, Universities

Purpose of programme/project

The primary aim of the Steel Research Hub is to enable the Australian steel industry to improve its global competitiveness. By adopting an integrated, value chain-wide approach to innovation in the steel sector and by ensuring sector-wide industry representation and collaboration the Hub aims to deliver tangible and lasting economic and environmental benefits, and to ensure future research capacity in the field.

The Steel Research Hub is undertaking four broad programs of research to achieve its aims. These are Innovation Management, Market-focused Product Innovation, Innovative Coating Technologies and Sustainable Steel Manufacturing.

The Innovation Management Program constitutes a small but significant part of the Hub's budget and reflects the recognition by our industry partners that successful innovation is key to developing, and commercialising, the cutting edge products and processes that underpin a successful business.

Innovation Management sits as an umbrella across the Hub's entire research program, however, particular synergies have emerged with the Market-focused Product Innovation Program, which has a mixture of near and long-term goals for product development. An example of a short-term goal is research aiming to improve the performance of current quench and tempered (Q&T) plate steels produced by Bisalloy Steels, the results of which will be deployed immediately.

A long-term goal is to develop models and prototypes that demonstrate the benefits of using steel in the construction of mid-rise residential buildings, which presents an extremely complex challenge to the steel industry in Australia, where concrete is dominant.

The Innovative Coating Technologies Program looks at improving current processes in the production of coated steel products by BlueScope. BlueScope has built an impressive reputation in this field, off the back of years of research and development to put its products at the forefront of performance for the category, and continued advancement is this space is critical to BlueScope's strategy.

Finally, the Sustainable Steel Manufacturing Program involves both BlueScope and Arrium, Australia's two steel manufacturers, collaborating with researchers from a range of universities to reduce and optimise raw material and energy usage in steel making, to reduce both cost and greenhouse gas emissions.

Summary of collaborative approach

The Steel Research Hub brings together six industrial partners (BlueScope, Arrium, Bisalloy Steels, Lysaght, Australian Steel Institute and Cox Architecture) and six Universities (University of Wollongong, University of Queensland, University of Newcastle, Swinburne University of Technology, RMIT and Monash University).

Each of these participants comes together in different ways across a large number of specific projects depending on their expertise and interest. Some projects involve only two participants (one university and one industry partner), whilst others engage several participants.

BlueScope (and its predecessors) have been collaborating with the University of Wollongong (UOW) for at least 20 years. BlueScope has also previously worked with many other universities, some of which are also part of the Steel Research Hub, and also had an existing commercial arrangement with Bisalloy Steels. UOW had existing links with Arrium and Cox Architecture, but many of the collaborative connections within the Hub are relatively new.

Preparing the application for ARC funding prompted the key driving players, BlueScope and UOW, to consider broadening their own strong collaborative relationship to capture additional academic expertise, and more importantly, to engage with the broader steel value chain. The inclusion of Arrium means the Hub engages Australia's two largest steel manufacturers, whilst partnering with the Australian Steel Institute secures access to a large number of its member SMEs who are important stakeholders in the steel value chain.

Many of the projects being undertaken within the Steel Research Hub were forecast in the proposal put to the ARC for consideration for funding. However, prior to any research commencing all projects were re-evaluated, with a view to ensuring their ongoing relevance to industry, and subsequently detailed and formalised in individual project agreements.

The Hub has a comprehensive governance structure to implement and manage collaborative processes. This includes a Research Management Committee, with a membership drawn heavily from industry, to oversee funding allocations to projects and to assess overall progress. Each of the four programs within the Hub has an academic and industry leader. In addition, Project Agreements are structured so that each project has a leader (usually an academic researcher) and industry champion. This structure ensures that Industry representatives are systematically incorporated within each research project and all levels of governance.

Meetings at the Program level (here and here) and the entire Hub level, encourage cross-disciplinary collaboration by exposing all members to activity that would typically be outside their area of interest/exposure.

Analysis of collaborative approach

The Australian Research Council contributes $5 million cash over the 5 year program. This funding is matched by $5 million cash from BlueScope and UOW contributes $1.7 million. Additional cash contributions from other industry and university partners bring the total cash budget to $12.86 million. BlueScope and UOW provide the lion's share of in-kind

contributions ($5.5 million and $3.9 million respectively) with other contributions bring the total in-kind to $11.7 million.

A large proportion of the Hub's cash budget goes to supporting the employment of Post-doctoral research fellows (at least 14) and to PhD scholarships (at least 24). Remaining cash is largely allocated to direct research costs such as consumables and equipment to resource each research project. A key benefit to industry from this funding arrangement is that all research fellows and PhD candidates are expected to spend time in industry placements during their tenure. This ensures these young researchers develop a thorough understanding of the industrial challenges being tackled.

In-kind contributions include the time committed by academic and industry researchers and access to a broad range of facilities, including high end research labs and equipment hosted by universities as well as industrial plant facilities. It should be noted that, to date, the in-kind participation of industry parties has exceeded expectations, largely due to the increased numbers of industry staff participating in the research.

To balance the differing organisational drivers of the participants the ARC set a series of academic and industrial KPIs that the Hub must set targets for and report against annually. These KPIs are shared with all Hub members. In addition, individual Project Agreements are structured to include specific academic and industrial milestones, which each project is held accountable to. Project teams are encouraged to maintain opens lines of communication and to meet regularly.

The Hub's higher level Participants Agreement also plays a major role in striking a balance between differing organisational drivers. For example, the ability to publish academic papers must be balanced with oversight by industry to protect confidential or commercially sensitive information. The negotiation process for this overarching agreement involved detailed and sustained consultation, with leadership from BlueScope and UOW, to come to a successful outcome. The result is a robust reference document that serves to guide the Hub's administration.

A key element of the collaborative approach established for the Steel Research Hub has been the inclusion of industry staff and researchers at every level of governance. As an ARC funded research centre, hosted by a university, the Hub could easily be perceived as an academic pursuit. Our structure supports a genuinely collaborative engagement between academia and industry, which also avoids the perception of industry as customer.

Given that a comprehensive suite of projects was developed at the proposal stage, and there was a significant lag from proposal submission to commencement of the Hub, there was a clear danger that the research proposed was no longer relevant to industry needs. The Steel Research Hub's governance structure is such that each individual Project Agreement must be signed off by all participating parties. This ensures that projects are appropriately focused at the time of commencement and embedded checkpoint milestones enable ongoing monitoring for compliance and continued relevance over time. In addition to these formal mechanisms, facilitating the involvement of high-level industry stakeholders, such as through periodic Program meetings, ensures that projects maintain a valuable and relevant

focus for industry. At times projects will need to change focus and it is critical that this is enabled rather than prevented.

At any given time each individual project team is at a different state of evolution and maturity. It is essential that the level of support/brokering is tailored to individual projects and flexible over time. As described above the Steel Research Hub builds on existing relationships to form new collaborative arrangements. This means that some project teams were ready to hit the ground running, whilst other teams required a more nuanced and proactive establishment phase.

Details and analysis of impact

The Steel Research Hub is currently only 1 year into its 5 year research program but several beneficial outcomes can already be identified. The Hub was launched by then Minister for Industry Ian MacFarlane at an event in Parliament House in Canberra and this subsequently led to Mr MacFarlane visiting the Illawarra for the first time and touring both BlueScope's Port Kembla Steelworks and UOW's Innovation Campus.

A high level Advisory Council has been established for the Hub, meetings of which have in part resulted in the Hub attracting a new Industry Partner (Stockland) and discussions with CSIRO regarding potential collaboration between the Hub and their manufacturing and minerals resources groups (news release).

Hub researchers have also undertaken a small consultancy with the ACT government to assess and provide recommendations for a significant outdoor artwork, which was suffering extensive corrosion (news release).

Several Hub research teams have presented their initial work at a variety of conferences and Director, Oscar Gregory, contributed an invited piece to industry magazine the AusIMM Bulletin (news release) which has a readership of over 10,000 key stakeholders in the minerals sector.

A key element of the Hub's collaborative approach, which is expected to have a positive influence on research impact, is that a dialogue has been established that stresses the importance of putting research outcomes into trial within an industry environment as quickly as possible. In particular, process improvements will be tested and/or applied immediately on plant where possible and it is anticipated that fundamental/theoretical research will be informed by empirical work, not just in a laboratory setting, but on plant.