

# ANNUAL REPORT 2017



# ABOUT US

The Institute for Future Environments (IFE) is a transdisciplinary research and innovation institute at Queensland University of Technology (QUT) in Brisbane, Australia focused on grand societal challenges. Hundreds of QUT researchers and higher degree research students from across the fields of science, engineering, law, business, creative industries, health and education collaborate at IFE on large-scale projects relating to our natural, built and digital environments.

## Our mission

To generate knowledge, technology and practices that make our world more sustainable, secure and resilient.

## Our vision

To be renowned as a catalyst for:

- addressing global challenges that build a strong Australia, with a competitive economy
- delivering innovations through transdisciplinary collaboration
- nurturing the entrepreneurial spirit of researchers
- inspiring a generation to recognise STEAM (Science, Technology, Engineering, Arts and Mathematics) as being at the heart of the country's competitiveness.

# CONTENTS

2017 HIGHLIGHTS .....	1
MESSAGE FROM THE EXECUTIVE DIRECTOR .....	2
STRATEGIC ACTIONS FOR SUCCESS .....	3

TRANSDISCIPLINARY RESEARCH AND INNOVATION.....	5
Research theme: Growing the Global Bioeconomy .....	10
Research theme: Managing for Resilient Landscapes.....	16
Research theme: Infrastructure for Sustainable Communities .....	20
Research theme: Embracing the Digital Age .....	25
Enabling platform: Intellisensing .....	29
Enabling platform: Transforming Innovation Systems.....	34
Enabling platform: Manufacturing with Advanced Materials .....	38

CROSS-ORGANISATION RESEARCH INFRASTRUCTURE .....	43
Research infrastructure highlights.....	44
Central Analytical Research Facility (CARF).....	44
Visualisation and eResearch (ViseR) .....	45
Research Engineering Facility .....	46
Banyo Pilot Plant Precinct.....	47
Samford Ecological Research Facility (SERF).....	48
Mackay Renewable Biocommodities Pilot Plant.....	48

TRANSDISCIPLINARY RESEARCH CULTURE AND SUSTAINABILITY .....	49
Engagement and outreach .....	50
Events.....	52
Media.....	54
Awards and scholarships .....	57
People .....	58
Governance.....	60
Health, safety and environment .....	62
Research ethics and integrity.....	62
Financial report.....	63

# 2017 HIGHLIGHTS



## Transdisciplinary research and innovation

✓ **150+**

current research and consultancy projects

✓ **200+**

industry, government and academic partners

✓ **\$238,419**

Catapult funding awarded to launch QUT transdisciplinary research



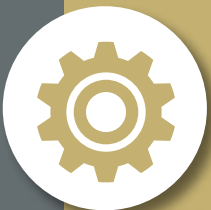
### AGRICULTURE

- QUT grows world-first Panama disease-resistant bananas (page 13)
- Converting industrial waste to valuable products (page 15)
- Cotton production to benefit from agri-intelligence (page 33)



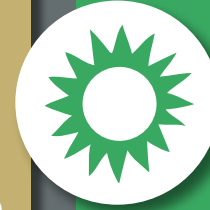
### ENVIRONMENT

- Scientists and farmers team up to wipe out African lovegrass (page 18)
- Crowdsourcing big data on eco sounds to monitor biodiversity (page 19)



### INFRASTRUCTURE

- Measuring the benefits and impacts of Queen's Wharf on Brisbane (page 23)
- Designing public parks that encourage people to get active (page 24)
- QUT research supporting Australia's future naval acquisition programs (page 32)



### ENERGY

- QUT creates Australia's first lithium-ion battery (page 41)
- New solar technology trial launched in Queensland (page 42)



## Cross-organisation research infrastructure

✓ **6** research facilities

✓ **600+** users of IFE-hosted research facilities

✓ **\$2.5 million** new assets



## Transdisciplinary research culture and sustainability

✓ **\$36 million** annual revenue

✓ **197 staff**, full-time equivalent

✓ **600+** researchers on IFE-aligned projects

✓ **Local, national and global** media coverage on IFE researchers and projects (page 54)

✓ **Award-winning** researchers (page 57)

# MESSAGE FROM THE EXECUTIVE DIRECTOR



The Institute for Future Environments (IFE) strives to improve people's lives by protecting and enriching their natural, built and digital environments. Our modus operandi is to build transdisciplinary teams of academics from QUT's faculties to solve the critical problems facing industry, government and the community. The essence of our work is forging collaborations to catalyse innovation. In 2017, we continued the work we started in 2016 of refining the institute's strategic direction and setting a clear plan for the years ahead.

In February, we held a Strategy into Action Forum to share IFE's 2017–2020 Key Priorities and Strategic Actions with the broader QUT community. With colleagues from QUT's faculties and divisions, we explored the opportunities and challenges the university faces in building an opportunity-responsive transdisciplinary institute doing high-impact applied research. Later in the year we released our 2017–2020 Strategic Plan, a fuller articulation of the global and national trends and challenges to which IFE is responding, and of QUT's and IFE's approach to research. Specifically, this is a problem-solving approach to fuel innovation-led growth.

The IFE Advisory Committee held its inaugural meeting in November (see page 60). We had a very productive conversation – testament to the great breadth and depth of experience of the committee members. Together they possess a deep understanding of the public, private and academic sectors in the US and Europe as well as Australia, and clear ideas about how those sectors can collaborate effectively. The ideas that came out of the meeting will inform IFE's planning in 2018 and beyond.

Throughout this report, you will find examples of IFE projects that are already having an impact on the real world. You can read about how our research themes and enabling platforms are, among many other things, producing commercial-grade lithium-ion batteries, designing public parks that encourage people to get active, converting industrial bio-waste into valuable products, helping farmers to wipe out African lovegrass, advancing Brisbane's digital revolution and mapping the origins of new energy technologies.

IFE's research infrastructure portfolio also made significant advances in 2017. At the start of the year, we established a new research facility, the Research Engineering Facility (REF), which services QUT academics and our partners from industry and government. REF provides specialist engineering services such as design, systems integration and data collection, management and processing, supporting QUT's core strengths in areas such as robotics and autonomous systems.

The Central Analytical Research Facility (CARF) opened a world-class nanoscale imaging laboratory accommodating two flagship instruments in the helium ion microscope and ultra-high vacuum scanning probe microscope. The specifically designed low-vibration characteristics of this new laboratory make generating images with atomic resolution possible. Our Visualisation and eResearch (ViseR) team designed and developed a crowd-sourcing solution for monitoring reef health using online and virtual reality tools. And at our Banyo Pilot Plant Precinct, we built a pilot facility that can rapidly prototype new battery formulations and cell types to help kick-start an Australian battery manufacturing industry.

Needless to say, it takes the passion and persistence of many people to achieve such results. I would like to acknowledge and thank all of IFE's staff, researchers and affiliates for making the institute a wonderfully productive and rewarding environment for transdisciplinary endeavour.

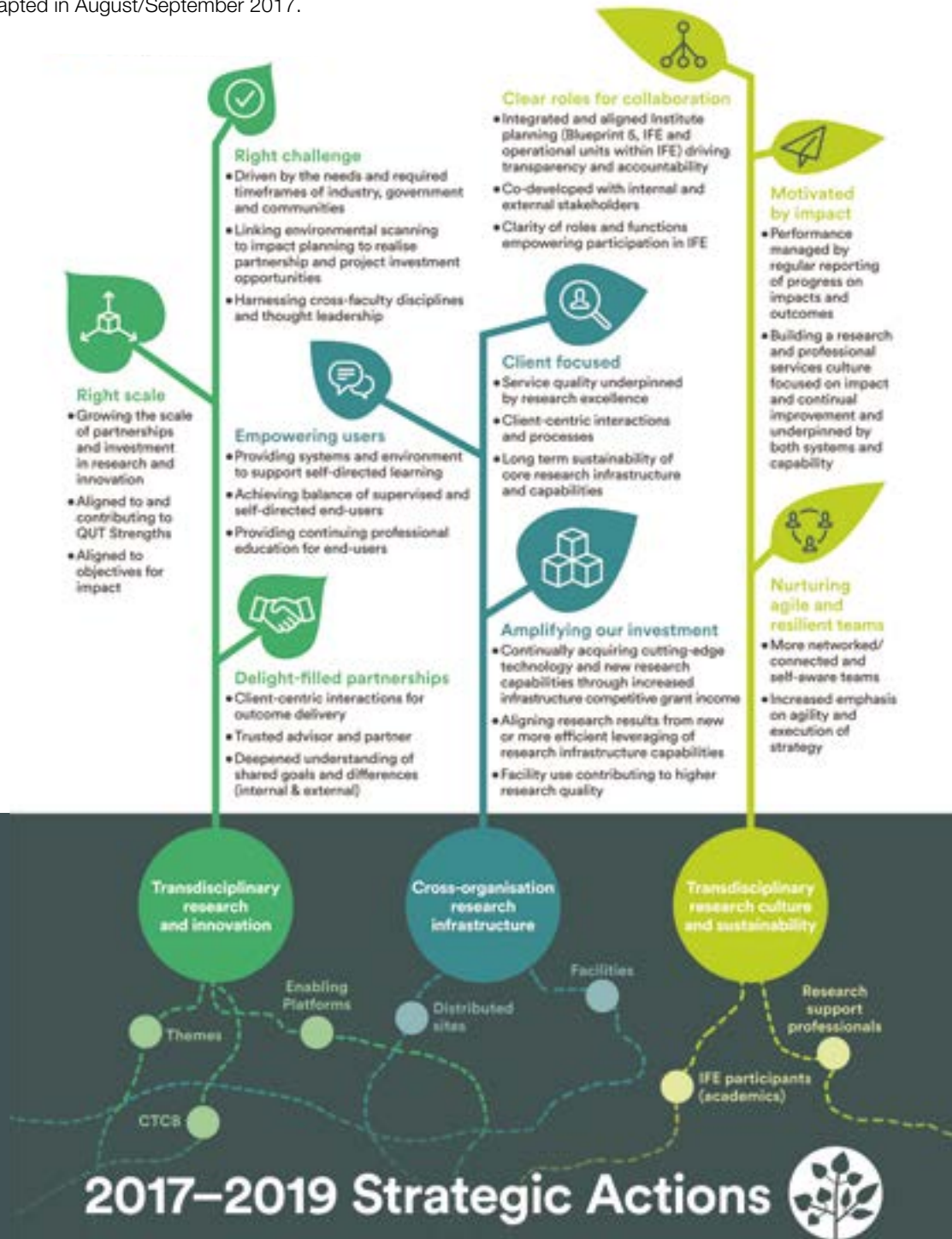
Finally, because almost everything we do is a collaborative enterprise, I would like to thank our partners and stakeholders for helping us to change the world – for real.

A handwritten signature in black ink that reads "B. Harch". The signature is written in a cursive, flowing style.

**Professor Bronwyn Harch**  
IFE Executive Director

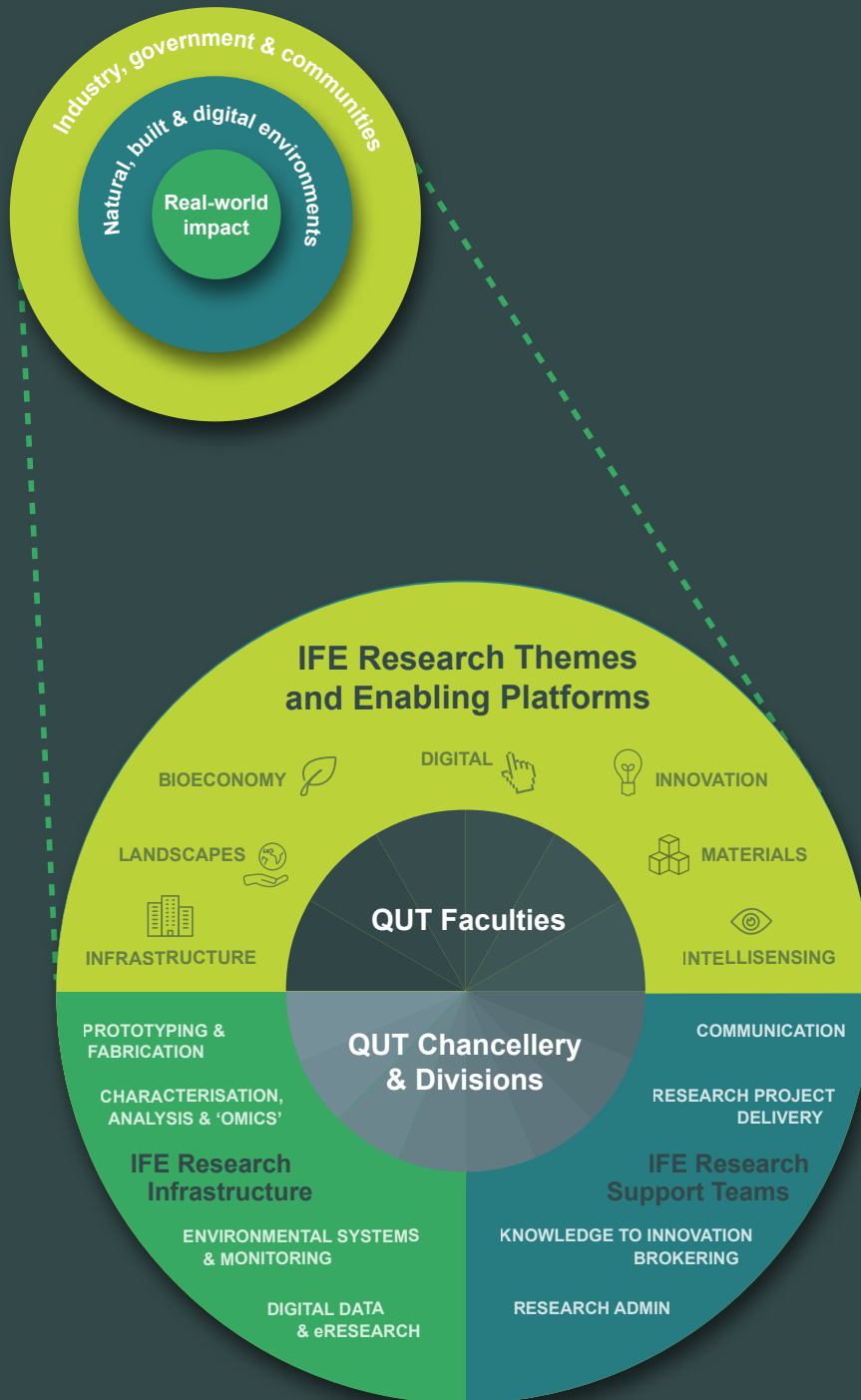
# STRATEGIC ACTIONS FOR SUCCESS

IFE's 2017–2020 Strategic Plan is built on three Key Priorities representing major portfolios of the institute's business, each one branching off into three sets of Strategic Actions, as shown in the diagram below. The Strategic Actions were developed with alignment to QUT's Blueprint (Strategic Plan) and through a series of consultations with IFE staff, IFE participants (academics working on IFE projects and using IFE facilities) and IFE stakeholders (QUT leaders and a subset of our end-user partners). The Strategy and Strategic Actions were launched to the IFE community in February 2017 and were adapted in August/September 2017.



# CATALYSING INNOVATION

IFE partners with industry, government and non-profits on projects to improve our natural, built and digital environments. IFE builds transdisciplinary teams of researchers from QUT's faculties, supported by first-class research facilities and research support professionals.



# TRANSDISCIPLINARY RESEARCH AND INNOVATION

Our researchers work in transdisciplinary teams, in partnership with industry, government and non-profit organisations, on projects to improve our natural, built and digital environments.



# Our research agenda

## Understanding the challenge

Our world is rapidly changing. Rising population and consumption levels are transforming the global economy and straining the environments that support human communities. Food, water, energy and information security are major concerns and the economic power base is shifting to emerging nations, cities and large companies.

The demand for natural resources and new materials is continually growing, while at the same time consumers expect the economy generally to have a lower environmental impact and greater social benefits.

Climate change is driving sea level rises and more severe weather patterns, which in turn threaten the stability of infrastructure systems and the health of natural landscapes and ecosystems. Climate change is also affecting the patterns of pests and diseases in natural and agricultural environments.

In Australia, as in many other countries, the population is growing, ageing and urbanising. Communities expect that public and private infrastructure – from energy and ICT networks to transport systems and buildings – will be integrated, sustainable and tailored to community needs.

Established Australian industries, such as agriculture and mining, are being transformed by new technologies and global competition. Advances in digital technology – especially in robotics, autonomous systems, sensor networks and mobile devices – are generating extraordinary volumes of data and giving us unprecedented power to extract information that helps us understand and manage our natural and built environments. These technological advances give rise not only to new opportunities, but also to new threats to our safety, security and privacy.

As people, landscapes, cities and things become more connected, our natural, built and digital environments are converging. This convergence is generating new challenges and opportunities in relation to Australian industry competitiveness, economic prosperity and environmental stewardship.

New opportunities are emerging, but the Australian innovation system – the path from discovery to deployment – is not working as well as it could. Many businesses and organisations do not have ready access to the knowledge and skills they need to be innovators,

distance often stifles the innovation process between research organisations and industry, and we struggle with the adoption of inventions.

In response to these global and national trends and challenges, IFE's research is designed to drive the following changes in the real world:

### Responsible development and management of Australia's natural resources and infrastructure

- New industries that profit from maintaining Australia's natural resource base emerge and grow
- Industry realises commercial opportunities by maximising Australia's geo-environmental context
- Governments and the public understand the trade-offs between social, economic and environmental values
- Trends in the condition of Australia's natural resources and infrastructure are monitored and reported
- Low-impact materials improve sustainability across product lifecycles.

### Building a more resilient Australian society

- Tools and information systems are developed that help governments, industry and communities to monitor and build the resilience of natural and built environments
- The innovation system is more integrated and effective, so that research efforts are not wasted and research breakthroughs benefit society more quickly
- Business and the public have greater confidence in responding to potential threats
- Spatially informed, secure information workflows are adopted by governments and society
- Infrastructure supports meaningful social, cultural and economic conditions, and vibrant and sustainable communities
- Landscapes, coastlines and seascapes are managed for resilience.

### Research and innovation for a more sustainable, secure and resilient world

QUT aspires to be a global leader in delivering research solutions to real-world problems. QUT's six faculties – Science and Engineering, Creative Industries, Business, Law, Education and Health – have broad expertise and research capabilities across the natural and social sciences. The university's excellence as a research



institution is grounded in conducting high-impact research that is:

- **responsive** – our research agenda reflects the human capital and innovation needs of the national and global economy
- **collaborative** – we work closely with partners in government, industry and the community not only to implement solutions but to define the research problems
- **transdisciplinary** – researchers from across many fields at QUT come together to address problems that no discipline could solve in isolation
- **technology-focused** – we leverage deep technological capabilities aligned to the university's research strengths and priorities.

IFE brings together hundreds of researchers and students from across QUT to collaborate on large-scale projects. We draw on the research strengths of QUT's faculties and schools, and the expertise and experience of well-established research centres such as the Centre for Tropical Crops and Biocommodities. We assemble transdisciplinary research teams, manage the research and innovation process and profile the impact of our research.

Many of the world's problems, and the solutions to them, lie at the intersections of our natural, built and digital environments. These environments support our food, energy, infrastructure and communication systems. IFE studies these interacting environments and systems – and their underlying social, cultural and economic context – and finds ways to make them more sustainable, secure and resilient.

IFE addresses social and economic challenges in a range of key sectors, including agriculture, mining, defence, environmental management, manufacturing, services, and information communication and technology. We collaborate with partners at every stage of the innovation process – from identifying problems and questions to developing new technologies, techniques and ideas through to final application and/or commercialisation.

IFE's research program comprises four research themes and three enabling platforms. Each research theme and enabling platform has an academic leader, a leadership

team with broad relevant disciplinary expertise, dedicated research support staff, a network of research academics from within all six faculties and research professionals within IFE facilities.

## Research themes

Our research themes are linked to specific societal challenges and sectors of the economy:

- **Growing the Global Bioeconomy** – food for all, better nutrition, valuable bioproducts
- **Managing for Resilient Landscapes** – monitoring and modelling ecosystems for sustainable development and stewardship
- **Infrastructure for Sustainable Communities** – planning, designing and building thriving communities
- **Embracing the Digital Age** – towards digital transformation, capitalising on strengths and mitigating challenges.

The scope and activities of the four research themes are covered in more detail on pages 10–28.

## Enabling platforms

Our enabling platforms are technologies, techniques and systems that can solve a wide range of problems for industry and society:

- **IntelliSensing** – transforming data collection, modelling, analytics and decision making
- **Transforming Innovation Systems** – increasing technology and information flow among people, enterprises and institutions
- **Manufacturing with Advanced Materials** – discovering and designing new and improved materials for diverse applications.

The scope and activities of the three enabling platforms are covered in more detail on pages 29–42.

Our research themes and enabling platforms are closely aligned with the Australian Government's and Queensland Government's Science and Research Priorities, which articulate the research areas of greatest significance to the state and the nation.

# Catapult: funding to launch QUT transdisciplinary research

In 2016, IFE launched a seed funding program to support research by QUT academic staff that is aligned to the institute's research themes and enabling platforms, and harnesses the capability of IFE's research facilities. The Catapult program is designed to enhance the technology readiness levels of promising transdisciplinary research ideas, ensuring that QUT research is able to move along the continuum from creative discovery and successful application through to adoption by industry or government. The funding is for projects that can be completed within 12 months, with a maximum amount of \$75,000 per application.

To support this initiative, IFE hosted a launch presentation on 1 June 2017 for almost 70 researchers from across QUT to tell them more about the application process. A showcase event was held on 1 November to allow project leaders to provide progress updates on 2016 and 2017 Catapult projects. Each project team was allocated a Knowledge to Innovation Broker to assist them in moving their project toward industry engagement and investment.

## FAST FACTS

- **Two Catapult funding rounds**
- **29 applications**
- **Six new transdisciplinary research projects approved**
- **\$238,419 awarded by IFE**

Project title	Project leader	Impacts	Participating faculties, centres and facilities
<b>Growing the Global Bioeconomy</b>			
Extracting high-value metabolites from banana biomass waste	Dr Fatima Eftekhari	Bioeconomy inputs are more sustainable (1) Bioeconomy industries are profitable (3)	Science and Engineering Faculty; Centre for Tropical Crops and Biocommodities; QUT Business School; IFE Central Analytical Research Facility (CARF); IFE Mackay Renewable Biocommodities Pilot Plant
<b>Managing for Resilient Landscapes</b>			
Low-cost desalination of impaired water resources for agricultural applications	Professor Graeme Millar	Increased resource use efficiency and productivity (5)	Science and Engineering Faculty; QUT Business School; Creative Industries Faculty; IFE CARF; Queensland Crop Development Facility
<b>Embracing the Digital Age</b>			
Identifying and responding to online abuse and harassment through machine learning models	Associate Professor Nic Suzor	Digital age contributes to a more resilient society by fostering strong and inclusive communities (10)	Law Faculty; Science and Engineering Faculty; Creative Industries Faculty; TrISMA (Tracking Infrastructure for Social Media Analysis); IFE Visualisation and e-Research
<b>Manufacturing with Advanced Materials</b>			
Demonstrating effective recycling of fast fashion fibres	Associate Professor Robert Speight	Materials life cycle uses are more environmentally sustainable (17)	Science and Engineering Faculty; Centre for Tropical Crops and Biocommodities; Creative Industries Faculty; QUT Creative Enterprise Australia; IFE CARF
Cheaper and more effective face masks through design and paper science	Dr Tom Rainey	Healthy communities and individuals: industry shares equitably the benefits of new materials with communities (18)	Science and Engineering Faculty; Creative Industries Faculty; Faculty of Health; QUT Design Lab; Centre for Children's Health Research
Design and manufacturing of gradients object	Dr Aurelien Forget; Dr Deb Polson	Global industries using advanced materials are more resource efficient (16)	Science and Engineering Faculty; Creative Industries Faculty; HUB Studio (part of Creative Industries Design Lab)

## 2016 Catapult project update

In 2016, IFE approved 12 research projects with a total of \$532,655 funding awarded in three rounds. A diverse range of research was funded including regulation of sugarcane farming, 'healing gardens' at the Lady Cilento Children's Hospital, 3D simulation of future fruit, integrated lighting for older people's homes and developing a legal framework for autonomous robotics. Several detailed examples are provided below.

### Veganism as a vehicle to grow the global bioeconomy



Guests at Pure Planta Fiesta learn more about vegan foods

This project, led by Dr Ozgur Dedehayir, involved researchers from the QUT Business School and Creative Industries Faculty and external stakeholders including Vegan Australia, vegan food suppliers and food connoisseurs. The research aims to investigate the adoption of plant-based foods, and how this new customer segment might provide environmental benefits by reducing reliance on meat-based protein. A highlight was the Pure Planta Fiesta event held at the Brisbane Powerhouse in October, involving food demonstrations and a vegan cooking challenge. As a result of this research, Pure Planta is now a registered business which is establishing connections with industry partners to further cultivate Australian vegan innovation ecosystems.

### A generic IntelliSensing software platform to support data-enabled decision making



Led by Dr Erin Peterson, researchers from QUT's Science and Engineering Faculty and IFE's Visualisation and eResearch (ViseR) team worked together to deliver MyGlobe, a generic software platform that successfully connects data, modelling, visualisation and interaction workflows. This platform has been tested for its ability to upload, process and visualise complex spatial information such as agricultural and stream sensing data. There are plans to expand the use of this platform by QUT researchers and develop a business model to enable it to be offered to external clients.

### Bio-hydrogen production from microbial electrolysis cells



This project, led by Associate Professor Anthony O'Mullane (left), involved external partner Pacific Northwest National Laboratory (PNNL) and researchers from QUT's Science and Engineering Faculty, Centre for Tropical Crops and Biocommodities and Central Analytical Research Facility. The project aims to generate hydrogen in an environmentally stable manner. Traditional technology involves splitting water into hydrogen and oxygen using an electrolysis cell, which is energy intensive. Using microbes to help in the production of hydrogen reduces the energy required. This has led to a new capability at QUT to construct microbial electrolysis cells as well as develop new catalyst materials for producing hydrogen. This partnership with PNNL will contribute to a research proposal to Australian Renewable Energy Agency for hydrogen production from renewable sources.

# Research theme: Growing the Global Bioeconomy

Leadership	
<b>THEME LEADER</b>	<ul style="list-style-type: none"> <li>• Professor Roger Hellens</li> </ul>
<b>LEADERSHIP TEAM</b>	<ul style="list-style-type: none"> <li>• Science and Engineering: Associate Professor Robert Speight; Dr Peter Prentis; Dr Melody de Laat; Dr Pawel Sadowski; Dr Kevin Dudley; Associate Professor Matthew Phillips</li> <li>• QUT Business School: Dr Judy Matthews</li> <li>• qutbluebox: Callum Hickey</li> <li>• Knowledge to Innovation Broker: Dr Susan Theiss / Dr Mark Gibbs</li> </ul>
<b>HOSTED QUT RESEARCH CENTRE</b>	<ul style="list-style-type: none"> <li>• Centre for Tropical Crops and Biocommodities</li> </ul>

Real-world context	
<b>KEY TRENDS</b>	<p>One in eight people around the world do not have enough food to eat, and one in four have nutritional deficiencies. By 2050, global food demand is projected to increase by 70 per cent. About a third of all food produced for human consumption is lost or wasted, yet little of this waste is converted to valuable by-products. Society increasingly expects agricultural operations to be environmentally friendly and sustainable, but many people are still resistant to genetically modified agricultural products.</p>
<b>GRAND CHALLENGES</b>	<ul style="list-style-type: none"> <li>• Meeting human needs for food, feed, fibre and fuel as the global population grows</li> <li>• Transforming the bioeconomy to make it more productive, profitable and sustainable</li> <li>• Raising public awareness of the safety and benefits of genetically modified agricultural products</li> </ul>

Our research strategy	
<b>FOCUSES</b>	<p>We are investigating how to:</p> <ul style="list-style-type: none"> <li>• develop crops with improved nutritional value, taste and convenience</li> <li>• reduce reliance on water, nutrients and sprays</li> <li>• add value to commodity crops</li> <li>• turn surplus biomass into sustainable fuels, chemicals and other valuable products.</li> </ul>
<b>IMPACTS</b>	<p>Our research is designed to drive the following changes in the real world:</p> <ul style="list-style-type: none"> <li>• more profitable bioeconomy industries</li> <li>• more sustainable bioeconomy inputs</li> <li>• increased health benefits from food.</li> </ul>
<b>MEASURES</b>	<p>We are tracking the impact of our research using the following lead indicators:</p> <ul style="list-style-type: none"> <li>• research funding for new cultivar/technology pair development</li> <li>• the number of genetically modified or advanced breeding products QUT has moved up the technology readiness scale</li> <li>• the number of bioprocesses run at pilot scale per year (moving up the technology readiness scale or validation of commercial processes in Australia).</li> </ul>

## Research and impact highlights

It was a very exciting year for the Growing the Global Bioeconomy theme and the Centre for Tropical Crops and Biocommodities (CTCB), with significant individual and team success in securing funding and building partnerships to achieve outcomes and address challenges.



Our efforts to develop a **bioeconomy with more sustainable inputs** was boosted by QUT's partnership with the Centre for Fruit Fly Biosecurity Innovation. As an ARC-funded Industrial Transformation Training Centre, the centre aims to protect horticulture industries and market access, and help ensure Australia's food security.

We moved closer to achieving a **significant impact on human health** by developing high pro-vitamin A bananas in Uganda due to successful Phase IV funding by the Bill and Melinda Gates Foundation for QUT's banana biofortification project. This next phase of funding ensures the partnership between QUT and the Foundation, which began in 2006, will continue for a further four years.

During 2017, our efforts to make **bioeconomy industries more profitable** has been supported through the Rural R&D for Profit initiative aimed at adding value to the waste streams from the meat industry. Our researchers are also working with the Queensland Government to attract bioindustry investment.

Our strong engagement with the tropical pulses industry in Queensland was strengthened with the award of three Advance Queensland Research Fellowships to Dr Brett Williams, Dr Sudipta Das Bhowmik and Dr Thi My Linh Hoang to develop more resilient and nutritious chickpea and pigeonpea varieties.

Our fermentation research capability has been boosted by the approval of a fermentation lab at QUT's Gardens Point campus, and by QUT's partnership with Bioproton. In addition, we are providing University Biosafety Committee services for an Advance Queensland-funded collaboration to develop advanced animal feed.



Our existing partnerships continue to grow, with Sugar Research Australia investing a further \$1.6 million in training, processing and fibre quality of new cultivars. This investment builds on more than 12 years of collaboration between QUT, Sugar Research Australia (formerly BSES) and the Sugar Research Institute.

A strategic collaboration with the US has resulted in Professor Chris Tindal (ex-US Navy) and Professor Alex Beliaev (Pacific Northwest National Laboratory) becoming adjunct and joint appointments at QUT respectively.

Our strategic partnership with The New Zealand Institute for Plant & Food Research continues to grow, with visits from their senior executives, chief scientist and key researchers, and QUT staff visiting New Zealand during 2017. QUT is also hosting two staff from The New Zealand Institute for Plant and Food Research to investigate pollination.

Our investment in IFE's Catapult funding continues to deliver benefits. The Future Fruit simulation was featured at the 2017 World Science Festival at South Bank, in the Ekka's Agriculture Education Hall (Advance Queensland display), and on Scope, a children's science TV program. The simulation was also used by QUT's Health Faculty to help student dieticians develop novel foods to address nutrition deficiency scenarios. The 'Veganism as a vehicle to grow the global bioeconomy' Catapult project secured support from local and international restaurants to run a plant-based food fiesta at Brisbane's Powerhouse on 21 October.



*Roger Hellens, Growing the Global Bioeconomy Theme Leader*



*Sagadevan Mundree, Centre for Tropical Crops and Biocommodities Director*

---

## Showcase events

### Working with the Livestock Industry: A Strategic Workshop

21 April 2017



IFE held a workshop with 50 QUT researchers from a range of disciplines who have (or would like to have) research partnerships with the livestock industry. This followed identification of the livestock industry as a strategic research focus for growing the global bioeconomy. Attendees discussed industry challenges, partners and projects and how best to coordinate industry collaboration.

### IFE Workshop: Debunking Myths – Developing Communication and Engagement Strategies

23 June 2017

About 45 researchers and science communicators attended this training workshop on two-way communication, engagement principles and strategies for emerging technologies, such as advanced biotechnology and genome editing. The workshop was facilitated by Dr Wendy Russell, a sessional academic at ANU's Centre for the Public Awareness of Science and associate of University of Canberra's Centre for Deliberative Democracy and Global Governance. Following this training, QUT researchers conducted interviews with the Brisbane public about the use of gene editing and ran sessions on gene editing in Gladstone, Mackay and Townsville with Life Sciences Queensland. These initiatives were supported by an Advance Queensland Engaging Science Grant.

### QUT War on Waste: A Transdisciplinary Forum on Food and Fashion Waste

16 October 2017

More than 70 representatives from QUT, industry, government and not-for profit organisations attended this forum to discuss the complex challenges and possible solutions to the global problems of food and fashion waste. The forum revolved around the supply chain, demonstrating how sustainable action on farms, during processing and by retailers and consumers can all play a

part in reducing food and fashion waste. QUT researchers presented on bioprocessing, supermarket campaigns to sell wonky fruit and vegetables, the tension between food waste and food insecurity, and the need to close the loop on resource wastage in the garment production supply chain. External speakers included representatives from government, farming and fashion giant H&M.



### Growing Global BioeconOMICS Workshop

30 November 2017

About 40 researchers attended a workshop showcasing QUT's capabilities in 'omics' research in the bioeconomy sector. The workshop featured presentations from CARF researchers in proteomics, metabolomics and environomics; sessions by external speakers from CSIRO, Queensland Cyber Infrastructure Foundation, NeCTAR Genomics Virtual Laboratory and the Australasian Open Access Strategy Group; and the chance to tour CARF laboratories.

### Centre for Tropical Crops and Biocommodities (CTCB) seminars

The CTCB regularly presents research by QUT staff and external experts, and hosts confirmation seminars by PhD students. During 2017, 46 seminars were held with an average of 35 people attending. Guest speakers included representatives from the CSIRO, SCION New Zealand, An Giang University (Vietnam), Meiji University (Japan), The University of Queensland (AIBN/QAAFI), Griffith University, University of Southern Queensland and Spiegare Pty Ltd.

### Conference sponsorships

QUT research was represented at The Australasian Bioenergy and Bioproducts Symposium (TABBS) in October and TropAg2017 in November.

## Case study: Saving Cavendish – QUT grows world-first Panama disease-resistant bananas

<b>Project or program title</b>	Generation of bananas with resistance to Fusarium Wilt
<b>Research theme or enabling platform</b>	Growing the Global Bioeconomy/Centre for Tropical Crops and Biocommodities
<b>IFE impact alignment</b>	Bioeconomy inputs are more sustainable (1)
<b>QUT project team</b>	Centre for Tropical Crops and Biocommodities: Distinguished Professor James Dale, Professor Robert Harding, Dr Anthony James, Dr Jean-Yves Paul, Professor Peter Waterhouse Science and Engineering: Distinguished Professor Kerrie Mengersen
<b>Partner organisations</b>	Australian Research Council, La Manna Banana's Darwin Banana Farming Company, Wageningen University and Research Centre (The Netherlands)
<b>Timeline</b>	2004 – ongoing

### Why it matters

Australia's commercial Cavendish banana crops are under serious threat due to Panama disease, a virulent soil-borne fungus also known as Fusarium wilt tropical race 4 (TR4). The disease is easily spread in tropical conditions and can remain in the soil for more than 40 years, causing banana plants to yellow, wilt, split and eventually die. Currently there is no effective chemical control for TR4, which makes the disease a huge problem for growers. Worldwide banana production is under significant threat with TR4 already destroying Cavendish banana plantations in many parts of the world, with the disease spreading rapidly across Asia and now present in Africa.

### How the IFE is making an impact

In a world-first, QUT researchers have developed and grown genetically modified (GM) Cavendish bananas which are resistant to the devastating fungus TR4. Project leader, Distinguished Professor James Dale from QUT's Centre for Tropical Crops and Biocommodities, said the results of field trials provide a solution for controlling the disease and protecting the global export of Cavendish around the world.

In a ground-breaking GM field trial conducted in heavily TR4-infested soil, one Cavendish line transformed with a gene taken from a wild banana from south-east Asia (RGA2) remained completely TR4 free. Three other lines showed robust resistance, with 20 per cent or fewer plants exhibiting disease symptoms in three years. By contrast, 67-100 per cent of control banana plants were either dead or TR4-infected after three years. The three-

year field trial, from 2012 to 2015, was conducted on a commercial banana plantation in the Northern Territory previously affected by TR4. The soil was also heavily reinfested with disease for the trial. Researchers used IFE's plant houses at the Queensland Crop Development Facility in the Redlands as part of the trial.

As a result of this QUT research, banana growers now have a Cavendish banana resistant to TR4 that could be deployed, after deregulation, for growing in soils that have been infested with the fungus. Future research will include expanded field trials and investigations into the use of gene editing to switch on genes in Cavendish bananas to increase their resistance to TR4 and other diseases.



*QUT Distinguished Professor James Dale with a resistant Cavendish banana plant in the lab.*

### Research infrastructure for the real world: Queensland Crop Development Facility

Situated at the Redlands Research Facility, this 22-hectare tropical, subtropical and molecular farming research facility, owned by the Queensland Government and managed by the Department of Agriculture and Fisheries, includes five glasshouses and field plots for crop trials. QUT researchers are able to access this space for important research.

## Case study: Protecting bee health

<b>Project or program title</b>	Microbiology and bees
<b>Research theme or enabling platform</b>	Growing the Global Bioeconomy
<b>IFE impact alignment</b>	Bioeconomy inputs are more sustainable (1)
<b>QUT project team</b>	Science and Engineering: Associate Professor Caroline Hauxwell; Dr Flavia Massaro; Andrew Dickson; Lille Gill; Nathaniel Crane; Boyd Tarlinton; Dr Marion Bateson; Dr David Hurwood Creative Industries: Associate Professor Thea Blackler; Daniel Cook
<b>Partner organisations</b>	The New Zealand Institute for Plant & Food Research
<b>Timeline</b>	2017

### Why it matters

Australia is home to more than 5000 species of bees and they are critical to the pollination of horticultural crops and wild plants. However, bee health is in decline around the world. According to the CSIRO, potential threats to bee health include pathogens, air and water contamination, pesticides, extreme weather, hive management, or a combination of factors.

### How the IFE is making an impact

A team of QUT researchers are examining the diseases that affect our native bees, how the microbiota of bees and hives can improve their fitness, and how bees interact with pathogens of the plants they pollinate.

QUT's Central Analytical Research Facility is supporting commercial, graduate and undergraduate research in microbial analytics, bee health and ecology. Advanced 'omics' are used to characterise the microorganisms that make up the bee hologenome and identify not just pathogens but the variants, or quasispecies, within pathogen populations that may be emerging threats. Researchers are also using mass spectrometry to identify the compounds in food stored in hives that may support bee health and development, and to characterise microorganisms that play a critical role in bee health.

QUT's expertise in plant and insect pathogens and the use of insect containment facilities at IFE's Samford Ecological Research Facility (SERF) is critical to research being conducted for The New Zealand Institute for Plant & Food Research. This research seeks to prevent the accidental spread of a plant pathogen called Myrtle Rust (*Puccinia psidii*) through the movement of honey

bee hives. This will benefit efforts to limit the impact of this pathogen, and also support the beekeeping industry through clear recommendations for hive movements in infected areas.

The 50 hectares of woodland and grassland at SERF is also home to native solitary bees, allowing researchers to identify pathogens of larvae and assess the potential spread of disease to native wild bees from introduced honey bees.



'Our wide-ranging research into the biology of pollinating insects and the plants that they pollinate requires us to build effective collaborations with research partners who can provide specialist skills and facilities to answer key questions.' - David Pattemore, Science Team Leader – Pollination and Apiculture, The New Zealand Institute for Plant & Food Research.



QUT researcher Associate Professor Caroline Hauxwell working in the field on hives within the Samford Ecological Research Facility insect screenhouses.



## Case study: Converting industrial waste to valuable products has big benefits

<b>Project or program title</b>	Advance Queensland Fellowship - Transforming Queensland agricultural and petroleum waste products into biochemicals and advanced composites
<b>Research theme or enabling platform</b>	Growing the Global Bioeconomy/Centre for Tropical Crops and Biocommodities
<b>IFE impact alignment</b>	Bioeconomy industries are profitable (3)
<b>QUT project team</b>	Centre for Tropical Crops and Biocommodities: Dr Kameron Dunn, Dr Phil Hobson, Professor William Doherty, Mr Neil McKenzie, Dr Lalehvasb Moghaddam, Ms Wanda Stolz, Mr Adrian Baker, Dr Darryn Rackemann
<b>Partner organisations</b>	Queensland Government, NilWaste Energy, Queensland Urban Utilities, Southern Oil Refinery
<b>Timeline</b>	2017 – 2021

### Why it matters

Excessive industrial waste is a global problem affecting our economy, society and environment. Australian agricultural and petroleum industries generate a significant amount of waste by-products, including sugarcane waste, biosolids, asphalt residue, end-of-life plastics and tyres. Generally, this waste is not easily biodegradable and has no real commercial value. Minimising, transforming and recycling these waste products into alternative and valuable resources has significant benefits for industry, community and the environment – both now and for future generations.

### How the IFE is making an impact

IFE research is supporting the growth of a sustainable industrial biotechnology and bioproducts sector in Queensland by supporting the conversion of industrial waste products such as sugarcane waste and old tyres into valuable and reusable materials and resources.

In partnership with NilWaste Energy, Queensland Urban Utilities and Southern Oil Refinery, QUT is supporting an Advance Queensland Fellowship (AQF) project exploring the ability of the thermochemical technologies called hydrothermal liquefaction and pyrolysis to minimise, transform and recover value-adding products from sugarcane waste (bagasse, lignin, vinasse), petrochemical waste (asphalt residue, end-of-life plastics, tyres) and sewage feedstocks. The research is being led by Advance Queensland Research Fellow Dr Kameron Dunn from QUT's Centre of Tropical Crops and Biocommodities (CTCB).

QUT's industry partners benefit from new income streams, significant reductions in waste transport and disposal costs, energy recovery and the production and recycling of value-adding and nutrient products. At the same time, these benefits provide protection to the natural environment and create sustainable industries for future generations.

### Research infrastructure for the real world

As part of the AQF project, NilWaste Energy will construct a patented pilot pyrolysis system at the IFE Banyo Pilot Plant Precinct to demonstrate and validate off-takes produced from pyrolysis processing. QUT's Mackay Renewable Biocommodities Pilot Plant pre-treats bagasse to produce sugarcane lignin, which is then processed at the Banyo facility. Laboratory equipment in QUT's Central Analytical Research Facility will also be used during the project.



'Queensland Urban Utilities' Research, Development & Innovation program supports strategic initiatives that create value for our customers by building organisational knowledge and capabilities through funding, resources and expertise. The opportunity of partnering with QUT, NilWaste Energy and Southern Oil Refinery under an Advanced Queensland Fellowship project is of significant interest to our business.' – Matthew Mulliss, Queensland Urban Utilities



Assistant Minister for State Development and Member for Mackay Julianne Gilbert (left), Minister for the Environment, Great Barrier Reef, Science and Arts Leeanne Enoch, and QUT researcher Dr Kameron Dunn (right) at the Mackay Renewable Biocommodities Pilot Plant.

# Research theme: Managing for Resilient Landscapes

Leadership	
<b>THEME LEADER</b>	<ul style="list-style-type: none"> <li>• Professor Peter Grace</li> </ul>
<b>LEADERSHIP TEAM</b>	<ul style="list-style-type: none"> <li>• Science and Engineering: Associate Professor Beverley Henry; Professor Les Dawes; Professor Ian O'Hara; Dr Grant Hamilton; Dr Susan Fuller; Dr Erin Peterson; Dr Matthew Dunbabin</li> <li>• Knowledge to Innovation Broker: Michelle Gane</li> </ul>

Real-world context	
<b>KEY TRENDS</b>	Landscapes and ecosystems around the world are under enormous pressure from growing human populations, natural habitat loss, shifting climate zones, changing land use priorities and increasing multinational competition for resources. Our livelihoods and wellbeing depend on the natural environment's productivity and health, which are based on the quality of the soil, water and air and the delivery of high quality ecosystem services.
<b>GRAND CHALLENGES</b>	<ul style="list-style-type: none"> <li>• Reducing greenhouse gas emissions and adapting to climate change</li> <li>• Sustainably producing 50 per cent more food and fibre by 2030</li> <li>• Maintaining the health of landscapes and ecosystems around the world and reducing the pressure on finite natural resources</li> </ul>

Our research strategy	
<b>IMPACTS</b>	<p>Our research is designed to drive the following changes in the real world:</p> <ul style="list-style-type: none"> <li>• improved resilience and condition of natural and managed ecosystems</li> <li>• increased resource use efficiency, productivity and profitability</li> <li>• increased ecosystem goods and services..</li> </ul>
<b>FOCUSES</b>	<p>We are investigating how to:</p> <ul style="list-style-type: none"> <li>• develop management solutions at a variety of spatial and temporal scales, from fields to catchments, from days to decades</li> <li>• use state-of-the-art environmental monitoring, simulation and analytical technologies and techniques to develop new management practices</li> <li>• provide cost-effective sustainable development solutions for land managers to increase the productivity and diversity of our ecosystems</li> <li>• maintain the quality of the air, soil and water and different ecosystems.</li> </ul>
<b>MEASURES</b>	<p>We are tracking the impact of our research using the following lead indicators:</p> <ul style="list-style-type: none"> <li>• participation in the environmental planning community</li> <li>• best management practices (BMPs) developed by QUT and promoted by industry</li> <li>• the number and value of externally funded projects on valuation of ecosystem goods and services.</li> </ul>

---

## Research and impact highlights

In 2017, the [Managing for Resilient Landscapes](#) theme confirmed its position as a key provider of practical innovative solutions to ensure the sustainable development of our natural and managed landscapes.

The theme continued to focus on the **efficient use of nitrogen fertilisers** to ensure Australia's agricultural systems are highly productive with minimal environmental impact. The theme's national leadership in the use of nitrogen isotopes in terrestrial environments underpinned significant investments from the Commonwealth Rural Research and Development Corporations (cotton, horticulture, dairy, grains, sugar) and the Commonwealth Department of Agriculture and Water Resources (through its More Profit from Nitrogen program). Our field research program extends from the Northern Territory (in collaboration with the Department of Primary Industries) to southern New South Wales.

The theme also led Australia's research effort in **reducing nitrous oxide** (a nitrogen-based greenhouse gas) **from the agricultural sector**, with strong links to the international Global Research Alliance for Agricultural Greenhouse Gases. Greenhouse gas mitigation projects are in place with Lincoln University (New Zealand), the International Crops Research Institute for the Semi-Arid Tropics (India) and the University of Ruhuna (Sri Lanka), with the latter projects funded by the Asia-Pacific Network for Global Change Research. New greenhouse gas projects are coming on stream in Vietnam and Fiji funded by the Australia Centre for International Agricultural Research.

IFE secured funding from the Queensland Department of Environment and Science to **reduce nitrogen pollution of waterways**, including the development of in-field bioreactors for nitrate removal (as featured on ABC Landline) and the use of innovative fertiliser products.

IFE's Catapult funding supported two projects within the theme. Dr Felicity Deane (Law) led a transdisciplinary team developing a regulatory response to nitrogen pollution of the Great Barrier Reef. Dr Erin Peterson led the development of a generic spatial technology software platform for data-enabled decision making (eg. satellite imagery and in-situ sensor data from waterways) supported by IFE's Visualisation and eResearch team. The latter project has led to externally funded projects with the United States Department of Energy and Bonneville Power Authority,

and an atlas for the Queensland Cancer Council. Dr Peterson's leadership was also instrumental in the development of social and biodiversity indicators for sustainability reporting within the Australian cotton industry (funded by the Cotton Research and Development Corporation).

The theme maintained a strong focus on **applying advanced remote and proximal sensing technologies** to plant production, biodiversity and animal ecology. Dr Grant Hamilton and Dr Simon Denman secured Queensland Government funding to deploy drones and automated identification to create a robust methodology for estimating koala abundance.

Professor Paul Roe has led the development of a national eco-acoustics network with major funding from the Australian Research Council ([see case study, page 19](#)). This vast network delivers the sounds of our landscapes to ecologists the world over and is the way of the future for rapidly assessing biodiversity and ecological responses to environmental change. This network builds on the theme's existing relationship with the Terrestrial Ecosystem Research Network (a National Collaborative Research Infrastructure Strategy), which is now in its seventh year with the IFE's Samford Ecological Research Facility as one of the national Supersites.

Associate Professor Jennifer Finn's research in **reducing the impact of invasive species** and improving ecosystem function in Australian grasslands is indicative of how the theme works closely with landowners and stakeholders to deliver innovative solutions to globally significant problems ([see case study, page 18](#)).



*Professor Peter Grace,  
Managing for Resilient  
Landscapes Theme Leader*

## Case study: Scientists and farmers team up to wipe out African lovegrass

<b>Project or program title</b>	The landholder-first philosophical principle: Integrating local knowledge and research to refine control strategies for an invasive plant species
<b>Research theme or enabling platform</b>	Managing for Resilient Landscapes
<b>IFE impact alignment</b>	Improved resilience and condition of natural and managed ecosystems (4)
<b>QUT project team</b>	Science and Engineering: Associate Professor Jennifer Firn
<b>Partner organisations</b>	NSW Government Office of Environment and Heritage, Far South Coast Local Land Services, Far South Coast Landcare Association
<b>Timeline</b>	2014 – 2017

### Why it matters

The highly invasive plant species of African lovegrass is threatening pastures and native grasslands Australia-wide. A native of southern Africa, the plant is very hardy and African lovegrass tussocks can grow so large they restrict the movements of livestock and become a hazard to farmers trying to navigate their properties. The plant thrives in drought conditions and tends to dominate paddocks and overwhelm endangered native grasses. Seeds for African lovegrass can germinate even up to 17 years of age and are dispersed by grazing animals, slashing, vehicles, water, fodder and wind. Australian landholders consider it a pest species because it is not selectively grazed by livestock and tends to dominate native pastures, reducing biodiversity and essential ecosystem functions.

### How IFE is making an impact

A partnership between QUT, the NSW Government and farmers could lead to the eventual eradication of the highly invasive African lovegrass, with research revealing that science combined with local knowledge is the key to a successful management approach.

QUT lead researcher, Associate Professor Jennifer Firn from QUT's School of Earth, Environmental and Biological Sciences led a field study working with 15 landholders in the Bega region of NSW. The study examined the changing ecological characteristics of grassy woodlands on landholder properties following the arrival of African lovegrass. Landholders generated hypotheses for 57 sites on the 15 properties, with many of their management decisions being validated.

The study also found the popular method of mechanically slashing African lovegrass and then putting a large number of cattle into the paddock only made the lovegrass more abundant, whereas spot spraying with herbicide was effective even with heavy infestations and cost-efficient despite having a poor reputation with landholders. Detailed soil nutrient analyses and plant tissue samples for the study were analysed in IFE's

Central Analytical Research Facility, and glasshouses managed by IFE were used for a detailed seedbank study that extended over six months.

This project highlighted the value of a team effort among scientists, governments, land care groups and farmers and the importance of sharing expertise to maximise understanding and provide more efficient management solutions.

Researchers found that working together with landholders to solve environmental issues led to improved, science-supported and publicly accepted ecosystem management strategies. This approach has provided strategies for controlling African lovegrass globally, and will be a model to help researchers and landholders better understand and manage other invasive plants and animals into the future.



Associate Professor Jennifer Firn from QUT's School of Earth, Environmental and Biological Sciences researching in the critically endangered grasslands of the Bega Valley with collaborator Dr Emma Ladouceur from iDIV, Leipzig, Germany.

“I firmly believe that this work will change how researchers and scientific and environmental organisations carry out their research... Ultimately, this work will not only directly benefit Australia's environment by providing management options for controlling African lovegrass but will also provide a template for developing solutions to any environmental problem.” – Professor Marc Cadotte, University of Toronto and Executive Editor of the Journal of Applied Ecology



## Case study: Crowdsourcing big data on eco sounds to monitor biodiversity

<b>Project or program title</b>	Australian Acoustic Observatory: A network to monitor biodiversity
<b>Research theme or enabling platform</b>	Managing for Resilient Landscapes
<b>IFE impact alignment</b>	Improved resilience and condition of natural and managed ecosystems (4)
<b>QUT project team</b>	Science and Engineering: Professor Paul Roe; Professor Margot Brereton; Professor Stuart Parsons; Associate Professor Tomasz Bednarz (now UNSW Sydney)
<b>Partner organisations</b>	The University of Queensland, University of New England, Charles Sturt University, James Cook University
<b>Timeline</b>	2017 – 2018

### Why it matters

The world's ecosystems are under pressure from population growth, urbanisation and climate change. Traditional methods for measuring the health or ecological condition of landscapes include labour-intensive manual surveys, field observations and sound recordings.

Since 2015, QUT researchers have been using a more efficient and non-invasive research method called eco-acoustics, which allows monitoring of the ecosystem through sounds. Acoustic sensing technologies allow for remote, automated collection of environmental data over time, which allows changes in ecosystem health to be tracked 24 hours a day, seven days a week. QUT researchers are already using this technique for conducting vegetation and landscape assessments, identifying animal species and monitoring bats. However, the large volume of data collected during eco-acoustic monitoring cannot currently be automated, so expert human analysis and interpretation is required.

### How IFE is making an impact

During 2017, the Australian Research Council approved funding of \$900,000 to establish an Australian acoustic observatory for environmental monitoring over five years. A research collaboration of ecologists, biologists and computer scientists will work together to establish an acoustic observatory to allow for analysis of Australia's fragile and diverse environment.

Professor Paul Roe from QUT's Eco-acoustics Research Group is a Chief Investigator Manager for the project, which involves the installation of 400 sensors and cloud storage of open access audio data from around Australia. Sounds detected and recorded through the sensors will provide a direct, permanent and objective record of the environment for use by researchers, citizen scientists and the general public. Together with QUT, other universities collaborating on the project include The University of Queensland, University of New England, Charles Sturt University and James Cook University.

These partners have contributed a further \$900,000 bringing total project funding to \$1.8 million.

The observatory will collect one of the largest terrestrial sound datasets in the world, recording audible species across multiple habitats, and providing high-resolution spatial and temporal data. Contributors will join forces to investigate new approaches to analysing big data to gain greater efficiencies. This nationally significant data will transform environmental science, including fauna survey and ecological assessment, and support transdisciplinary research between ecologists, biologists and computer scientists. For more details, visit [www.acousticobservatory.org](http://www.acousticobservatory.org)

### Research infrastructure for the real world

A solar-powered acoustic monitoring system is permanently installed at QUT's Samford Ecological Research Facility (SERF) as part of QUT's involvement in the Australian Government's Terrestrial Ecosystem Research Network.



Research Assistant David Tucker with an acoustic sensor at SERF.

# Research theme: Infrastructure for sustainable communities

Leadership	
<b>THEME LEADER</b>	<ul style="list-style-type: none"> <li>• Professor Laurie Buys</li> </ul>
<b>LEADERSHIP TEAM</b>	<ul style="list-style-type: none"> <li>• Creative Industries: Professor Robin Drogemuller; Professor Marcus Foth; Associate Professor Rosemary Kennedy</li> <li>• Science and Engineering: Professor Gerard Ledwich; Associate Professor Geoff Walker; Dr Marc Miska; Professor Margot Brereton; Dr Vicky Liu; Dr Lyndall Bryant; Dr Tracy Washington; Dr Susan Fuller; Professor Edward Chung</li> <li>• Knowledge to Innovation Broker: Mr Raymond Johnson</li> </ul>

Real-world context	
<b>KEY TRENDS</b>	<p>The world's population is growing, ageing and urbanising. Global demand for energy, water and resources is rising, while finite natural resources are declining. Communities expect that public and private infrastructure – from energy and ICT networks to transport systems and buildings – will be integrated, sustainable and tailored to community needs. New ways of designing, building and managing infrastructure are emerging in the transition from the industrial to the digital age.</p>
<b>GRAND CHALLENGES</b>	<ul style="list-style-type: none"> <li>• Creating infrastructure that enriches communities while being sustainable, resilient and responsive to climate change</li> <li>• Developing technology and systems that improve the planning, design and operation of infrastructure</li> <li>• Developing policy frameworks, funding systems and business models that deliver sustainable, community-centred infrastructure</li> </ul>

Our research strategy	
<b>IMPACTS</b>	<p>Our research is designed to drive the following changes in the real world:</p> <ul style="list-style-type: none"> <li>• infrastructure that is resilient and provides net benefits to the environment</li> <li>• infrastructure that supports connected and enriched communities</li> <li>• infrastructure models that are financially sustainable.</li> </ul>
<b>FOCUSES</b>	<p>We are investigating how to:</p> <ul style="list-style-type: none"> <li>• optimise the construction, performance and security of physical and digital infrastructure by evaluating how these systems interact, and how future systems should be built and managed</li> <li>• better manage major community infrastructure by developing new methods to understand system behaviour and response</li> <li>• enable faster and safer service delivery, to meet the growing demands of connected consumers, businesses and governments, by developing better ICT network infrastructure.</li> </ul>
<b>MEASURES</b>	<p>We are tracking the impact of our research using the following lead indicators:</p> <ul style="list-style-type: none"> <li>• the number of partnerships and projects between government, industry and QUT that address environmental impacts</li> <li>• the number of invitations for QUT to contribute to infrastructure planning processes (local, state and national)</li> <li>• the number of QUT foresight/environmental scanning projects engaging industry/government/community in the future of infrastructure.</li> </ul>

## Research and impact highlights

During 2017, the Infrastructure for Sustainable Communities theme focused on identifying challenges and building industry partnerships and alliances.

One key effort in 2017 was enhancing our collaborative research environment with government and industry in the area of **smart cities**. Given the complexity and changing nature of cities, our focus is on enhancing cities to be human-centred, innovative, resilient and sustainable through the development and application of powerful transdisciplinary knowledge generation, translation, application and education. We collaborated with a range of local governments, industry and international partners on identifying new approaches to challenges which we are translating into actions. For example, we are working with the Department of State Development to establish benchmark data for a Longitudinal Benefits and Impacts Study for Queen's Wharf, Queensland's largest ever development. Due to open by 2022, Queens Wharf will transform Brisbane's CBD with an integrated resort incorporating public space, an iconic sky deck, 50 eateries, retail, residential and tourist accommodation and a new pedestrian bridge.

We secured a strategic partnership with Technische Universität Darmstadt in Germany, and will be investigating smart city infrastructure development, including delivering meaningful real-time information to cities. Experts from [ui!] in Germany visited QUT to present their research on how smart city services benefit from urban data, and also met with councils in South East Queensland.

Dr Markus Rittenbruch, Professor Marcus Foth, Associate Professor Peta Mitchell, Associate Professor Tomasz Bednarz and Mr Bryce Christensen were part of the team that won the 2017 Sydney Smart City Award for Best Industry-led Partnership for their Rapid Analytics Interactive Scenario Explorer (RAISE) Toolkit. The project, a collaboration between UNSW and QUT, has developed an interactive geo-visualisation toolkit for land valuation models.



Our work in **energy and transport** directly contributes to infrastructure that is resilient and provides net positive benefits to the environment. Our focus

on the rise of the 'prosumer', energy sharing, mobility and economic, behavioural and social insights is delivering meaningful evidence for our industry partners, who are facing significant disruptions.

QUT will also be involved in the iMOVE Cooperative Research Centre's first research project, which involves a safety evaluation and user perception study of Australia's largest on-road testing trial of cooperative vehicles and infrastructure. This is a \$2.58 million, three-and-a-half-year research partnership to help prepare for and accelerate the emergence of cooperative technologies on Australian roads. QUT will work in partnership with the Queensland Department of Transport and Main Roads to undertake the safety evaluation research as part of the Queensland Cooperative Intelligent Transport Systems (C-ITS) Pilot Project. This will provide a core dataset to build a standardised analysis methodology and evaluate safety benefits of C-ITS.

During 2017, our research on developing **connected and enriched communities** was demonstrated by strong industry collaboration through our Senior Living Innovation (SLI) alliance. With our industry partners - Aveo, BallyCara, Bolton Clarke and IRT - we captured the perspectives of thousands of people on retirement and retirement living. The results demonstrated a significant gap between the stereotypical view of older people and the expectations of baby boomers. In partnership with Bolton Clarke, we challenged the design of the typical retirement village using participatory design principles and stakeholder engagement. The co-designed masterplan significantly changed over the engagement period from a gated/closed village to an open and welcoming community. After challenging the stereotypical view of terms such as old and elderly, the design philosophy and framework dramatically changed. The ways residents want to live and how they see themselves and their lives are important in the design process.



*Professor Laurie Buys,  
Infrastructure for Sustainable  
Communities Theme Leader*

---

## Showcase events

### Smart Cities Breakfast Series

During 2017, IFE hosted four Smart Cities breakfasts to bring together representatives from local government and utilities to discuss common issues and challenges with researchers, and to debate ideas and create new approaches to smart city challenges. Representatives from Brisbane City Council, Ipswich City Council and Logan City Council attended the breakfasts. Guest speakers included:

- Dr Pauline Zardo, QUT expert on health law research and digital media
- Philip Green, Queensland Privacy Commissioner and innovation and technology expert
- Dr Monique Mann, QUT Faculty of Law.

### Senior Living Innovation special preview event 27 April 2017



Senior Living Innovation is a major research collaboration between QUT and four leading industry partners; Bolton Clarke, Aveo, BallyCara and IRT Group. The initiative aims to reconceptualise the experience of ageing in Australia by informing policy development and decision-making in the senior living industry. It seeks to provide answers on where current and future seniors want to live, how they want to live in their community and the role that technology will play.

On 27 April, the research group welcomed a small group of VIPs to a breakfast networking event to discover how Senior Living Innovation will deliver robust evidence and commercially focused research outcomes for its partners. Attendees had the opportunity to get hands-on with cutting-edge research technologies and design-led innovation. They also received fresh insights from public engagement activities and social media mapping.

### Smart Cities Team Challenge 26 May 2017

To ensure thriving urban communities, our cities need to integrate technology into their infrastructure and manage their assets more effectively. On 26 May 2017, IFE hosted a Smart Cities workshop with key researchers, German experts and participants from local councils and utilities to brainstorm ideas about how to best shape our cities of the future. Representatives from Logan, Ipswich, Redlands and Moreton City Councils, CitySmart, Queensland Urban Utilities, Ergon, TMR, the Asset Institute, BlueBox and QUT participated in a half-day workshop, working in teams to propose a solution or strategy which was then pitched to a panel of judges. Representatives from international organisations including Mayor Bad Hersfeld, SAP Public Industries, SM!GHT EnBW, The Urban Institute and Continental Corporation also participated. Feedback was positive, with attendees reporting that the workshop helped them find common ground, greater insight and new synergies and ideas about creating their own individual smart cities.



## Case study: Measuring the benefits and impacts of Queen’s Wharf on Brisbane

<b>Project or program title</b>	Queen’s Wharf Longitudinal Benefits & Impacts Study: Phase 1
<b>Research theme or enabling platform</b>	Infrastructure for Sustainable Communities
<b>IFE impact alignment</b>	Infrastructure is resilient and provides net positive benefits to the environment (7); Connected and enriched communities (8)
<b>QUT project team</b>	Science and Engineering: Distinguished Professor Kerrie Mengersen, Associate Professor Paul Corry   IFE: Dr Mark Gibbs; Professor Michael Rosemann; Camilla Roberts; Annabelle Ramsay   Business: Dr Amanda Beatson Health: Dr Darren Wraith
<b>Partner organisations</b>	Queensland Government - Department of Innovation and Tourism Industry Development; Destination Brisbane Consortium
<b>Timeline</b>	2017 – 2018

### Why it matters

Between now and 2024, the city of Brisbane is undergoing a game-changing redevelopment with the transformation of prime riverside land into a \$3 billion integrated resort, entertainment and lifestyle precinct called Queen’s Wharf Brisbane. The precinct will eventually include 50 eateries, more than 1000 hotel rooms, 2000 residences, a 100-metre-high Sky Deck, relocation of the existing casino, 12 football fields of open space, and a new pedestrian bridge from the CBD to South Bank. Queen’s Wharf Brisbane will have a range of impacts including delivering new tourism investment in Brisbane, creating an internationally-recognised precinct attracting millions of local and international visitors, redefining Brisbane River public access and promoting social interaction.

In 2017, Destination Brisbane Consortium commenced demolition of many existing buildings and started enabling works on the massive site, which is set to undergo an unprecedented scale of excavation within the Queensland city centre during 2018.

### How IFE is making an impact

The Queensland Government’s Department of State Development has engaged IFE researchers to undertake a ground-breaking Longitudinal Benefits and Impacts Study for Queen’s Wharf Brisbane with all recognising that the collaboration of government, industry and the research sector is essential for monitoring the precinct’s benefits and impacts.

Work on this study, to be led by Distinguished Professor Kerrie Mengersen, commenced in October 2017 to assess the impacts and benefits of the Queen’s Wharf Brisbane development, with an initial focus on changes to connectivity, responsible gambling and public sentiment.

This research will provide timely, data-informed insights that could increase community confidence, enhance business and government operations, and provide opportunities to proactively improve benefits and minimise any negative impacts of Queen’s Wharf for Queensland.

To allow future changes to be measured in later studies, QUT researchers will be first establishing baseline measures. QUT will store, analyse and report on the baseline data for these studies and make recommendations for effective future studies in these areas.

In the future, QUT students may also be involved in providing innovative solutions to industry issues and participating in training and learning within the precinct.

For details, visit [www.queenswharfbrbane.com.au](http://www.queenswharfbrbane.com.au)

“The time to monitor and capture its benefits and impacts, is right now – at the very beginning. By doing this now, it better positions all to understand Queen’s Wharf Brisbane’s overall benefits and impacts.” – Queensland Department of Innovation and Tourism Industry Development



A concept image of the Queens Wharf Brisbane development.

## Case study: Designing public parks that encourage people to get active

<b>Project or program title</b>	Intergenerational park design for active and engaged communities
<b>Research theme or enabling platform</b>	Infrastructure for Sustainable Communities; in conjunction with the QUT Design Lab and IHBI
<b>IFE impact alignment</b>	Connected and enriched communities (8)
<b>QUT project team</b>	Creative Industries: Dr Debra Cushing; Professor Laurie Buys Science and Engineering: Dr Tracy Washington Health: Professor Stewart Trost
<b>Partner organisations</b>	Moreton Bay Regional Council; Playscape Creations; Conrad Gargett; 7 Senses Foundation; National Heart Foundation of Australia; National Wellness Institute of Australia
<b>Timeline</b>	2017 – 2020

### Why it matters

Physical inactivity costs the Australian economy \$13.8 billion annually and contributes to the fourth leading cause of death worldwide.

Many local parks and green spaces in suburban areas do not provide an attractive environment or innovative facilities that promote physical activity. Research shows that local and neighbourhood parks are generally under-used as a place for exercise.

### How IFE is making an impact

In 2017, QUT was awarded an ARC Linkage Project under which QUT researchers will collaborate with Moreton Bay Regional Council and other partners to investigate the key design considerations needed to create community parks that appeal to all ages and promote physical activity and social engagement.

A transdisciplinary QUT team representing landscape architecture, urban planning, exercise and nutrition science and gerontology will be involved, led by Dr Debra Cushing from the QUT School of Design. QUT will also collaborate with industry stakeholders including playground designers, landscape architects and physical activity advocates including the National Heart Foundation.

Research has shown that parks with unique natural attributes such as lakes, water or trails were more likely to be used. Enjoyable scenery, seeing others exercise, dog parks, programmed activities, safe conditions and regular maintenance all contribute to higher park usage. Playgrounds for children remain important, however they are not the only driver for making great parks for the whole community to enjoy.

Researchers will visit 12 Moreton Bay Regional Council parks to observe park usage and ask park users about which park amenities and features they used for physical recreation. Non-park users will also be asked about barriers to using parks and what could be done to address

those. Another unique aspect of the project is its focus on intergenerational park access and usage, looking at not only attracting young people to park and recreational facilities, but also their parents, grandparents and carers.

Moreton Bay Regional Council is already delivering fresh and imaginative playground designs and recreational spaces which appeal to young people of all ages and abilities. New facilities include a military-inspired parkour obstacle course in Clontarf and an adventure playground recognising sensory needs in Strathpine. Complete with hexagonal links and modular net obstacles, these sensory features supplement an existing children's maze, pedal-powered train and a nine-hole disc golf course.

The project will culminate in evidence-based design guidelines that specify innovative design principles and suggest cost-effective park features that can be used by local governments and park designers across Australia.

“Council is pleased to collaborate with QUT and looks forward to the outcomes of this exciting research project... we hope to better understand how we can improve existing parks and create new parks and spaces across our region which encourage residents of all ages to head outdoors and spend longer socialising and participating in physical activity, to keep our communities connected and active.” – Councillor Darren Grimwade, Moreton Bay Regional Council



*Dr Debra Cushing (L) and Dr Tracy Washington (R) are researching how to build all-ages public parks that invite people to exercise.*

# Research theme: Embracing the Digital Age

Leadership	
<b>THEME LEADER</b>	<ul style="list-style-type: none"> <li>• Professor Marek Kowalkiewicz</li> </ul>
<b>LEADERSHIP TEAM</b>	<ul style="list-style-type: none"> <li>• Business: Professor Larry Neale; Professor Uwe Dulleck</li> <li>• Creative Industries: Dr Debra Polson; Professor Axel Bruns; Dr Markus Rittenbruch; Dr Patrik Wikstrom</li> <li>• Education: Dr Mandy Lupton</li> <li>• Law: Professor Matthew Rimmer</li> <li>• Health: Professor Nicholas Graves</li> <li>• Science and Engineering: Associate Professor Richi Nayak</li> <li>• Knowledge to Innovation Broker: Raymond Johnson</li> </ul>

Real-world context	
<b>KEY TRENDS</b>	<p>Digital transformation of businesses and societies is one of the most significant drivers of the wellbeing of societies and individuals. Data is now recognised as an asset and value driver everywhere in the economy, in every sector and every organisation. Technologies including mobile devices, the Internet of Things, spatial information and big data analytics are having a significant impact on business productivity and processes. New opportunities and industries are emerging, and with them come new challenges and risks relating to privacy, access, security, crime and intellectual property.</p>
<b>GRAND CHALLENGES</b>	<ul style="list-style-type: none"> <li>• Identifying and capitalising on the commercial and social potential of emerging digital technologies</li> <li>• Positioning Australia to export digital services to the expanding Asian middle class</li> <li>• Developing vibrant tech start-up communities in Australia that can seize the opportunities presented by collaborative consumption and the sharing economy</li> </ul>

Our research strategy	
<b>IMPACTS</b>	<p>Our research is designed to drive the following changes in the real world:</p> <ul style="list-style-type: none"> <li>• stronger, more resilient and inclusive communities fostered by the digital age</li> <li>• increased value of tech businesses and digitally transformed businesses based in Australia</li> <li>• individuals benefit from digital transformation through reduced costs of living, access to new services and a higher quality of life.</li> </ul>
<b>FOCUSES</b>	<p>We are investigating how to:</p> <ul style="list-style-type: none"> <li>• improve business productivity and profitability by helping organisations to better understand their business, customers and competitors</li> <li>• predict and manage the impacts of emerging digital technologies on individuals, businesses and societies by focusing on legislation, sustainability and privacy</li> <li>• define new business strategies based on digital transformation of products and services.</li> </ul>
<b>MEASURES</b>	<p>We are tracking the impact of our research using the following lead indicators:</p> <ul style="list-style-type: none"> <li>• the difference in the number of public services offered in regional versus city locations</li> <li>• the operational efficiency of partners using QUT technologies</li> <li>• the number of people trained in QUT-structured ideation technique.</li> </ul>

---

## Research and impact highlights

During 2017, there were many research and impact highlights for the Embracing the Digital Age theme.

From a **digital strategy viewpoint**, we worked with Brisbane Marketing to co-create an updated digital strategy for Brisbane (*Digital Brisbane 2.0*), contributed to the Queensland Digital Strategy (*Digital1st*), and supported the Australian Government in preparing an Australian Digital Economy Strategy. More detail about *Digital Brisbane 2.0* is provided as a case study. A visit to MIT's Initiative for Digital Economy, SAP Palo Alto and Pixar broadened our understanding of the latest emerging digital technologies.

A report compiled by QUT's Digital Media Research Centre on *Australian Access to Digital Media Markets* was covered by Fairfax Media, including *Brisbane Times*.

QUT's role in designing **novel interactive installations** for the popular Marvel exhibition at Queensland Art Gallery and Gallery of Modern Art (QAGOMA) was a fantastic opportunity to spread the word about Dr Deb Polson's work in marrying the digital and physical worlds. We received press coverage across national news, TV and print with this initiative demonstrating a great confluence of art, technology, engineering and entertainment ([see case study, page 28](#)).

Our research also explored how the digital age has been disrupting the retail space. Dr Paula Dootson from the PwC Chair in Digital Economy team received high profile media coverage on 'designing out deviance in retail' with [news.com.au](#), [The Project](#) and [The Conversation](#), stemming from her research on the economics of self-service checkouts. Dr Debra Polson and her team installed a project at Brisbane's Wintergarden

called *Virtual Mannequins: Demonstrating the Future of Retail Experiences*. This is a new experimental work that presents and demonstrates future interactions and experiences with emerging technologies in public spaces so that we can contemplate the potential impacts as a community.



*Campus Morning Mail* ran an article on QUT research into Australians' digital access to US films, music, games and TV.

Several researchers within the theme won prestigious awards:

- Professor Marcus Foth won the Australian Computer Society Gold Disruptor award in the ICT Researcher of the Year category, on behalf of the Urban Informatics group in the QUT Design Lab that has been at the forefront of smart city research since 2006.
- Our researchers also won the Sydney Smart City award for best industry-led partnership for a project called Rapid Analytics Interactive Scenario Explorer Toolkit (RAISE) in collaboration with the University of NSW.
- Professor Fiona Naumann, Dr Deanna Grant-Smith and Associate Professor Nicolas Suzor received Australian Awards for University Teaching.

During 2017, our team contributed to many events to foster thought leadership and industry engagement, providing 53 keynote presentations reaching more than 3000 people. We also delivered 10 innovation sprints, with three progressing to implementation of a prototype.



*Professor Marek Kowalkiewicz,  
Embracing the Digital Age Theme Leader*

## Case study: Furthering Brisbane’s digital revolution

<b>Project or program title</b>	Digital Brisbane 2.0
<b>Research theme or enabling platform</b>	Embracing the Digital Age
<b>IFE impact alignment</b>	Digital age contributes to a more resilient society by fostering strong and inclusive communities (10); Increased value of technology and digitally transformed businesses based in Australia (11)
<b>QUT project team</b>	QUT Business School: Professor Marek Kowalkiewicz; Dr Paula Dootson Creative Industries: Dr Markus Rittenbruch; Irina Anastasiu
<b>Partner organisations</b>	Brisbane City Council; Brisbane Marketing
<b>Timeline</b>	2017

### Why it matters

The digital revolution has changed the face of business and industry across the world. Brisbane was the first Australian city and only the second city in the world to appoint a Chief Digital Officer and launched its first Digital Brisbane strategy in 2013. However, rapidly evolving technology has since created a significant digital divide for business and residents. Five years into Brisbane’s digital transformation journey, the needs of Brisbane residents and businesses have changed and the Brisbane City Council was keen to respond.

### How IFE is making an impact

During 2017, IFE researchers worked with Brisbane’s Chief Digital Officer, Cat Matson, to create *Digital Brisbane 2.0*, a strategy to empower businesses and residents to thrive in a globally connected, digitally-enabled world while maintaining our humanity.

In collaboration with Brisbane Marketing, QUT undertook detailed research analysing the best approaches to developing a digital strategy, in the form of an innovation sprint. As part of the work, the team invited a visiting academic expert in digital strategies for cities, Joachim van den Bergh from Vlerick Business School, to spend time with representatives from QUT and Brisbane City Council.

Specific initiatives of the strategy include:

- a global entrepreneur grant program that builds on the success of the existing Lord Mayor’s Budding Entrepreneurs Program
- a digital version of the world-renowned Brisbane Greeter program so visitors and residents can discover Brisbane’s offerings from the convenience of their smart device
- a digital festival developed in partnership with Brisbane’s established and successful digital businesses and industries
- an accessibility app to assist people with physical or mental impediments navigate Brisbane.

The *Digital Brisbane 2.0* strategy ([www.digitalbrisbane.com](http://www.digitalbrisbane.com)) was officially launched at a PwC Chair in Digital Economy event at QUT and was attended by more than 200 people on 31 August 2017. The event was opened by Cr Krista Adams and featured Cat Matson as a speaker.

The project team also produced *Digital Strategy for the Future*, a guide for organisations about the evolution of digital strategy and how to develop an effective strategy.



Cat Matson, Brisbane Chief Digital Officer

## Case study: Interactive technology makes exhibition visitors marvel

<b>Project or program title</b>	Marvel: Creating the Cinematic Universe
<b>Research theme or enabling platform</b>	Embracing the Digital Age
<b>IFE impact alignment</b>	Individuals benefit from digital transformation through reduced costs of living, access to new services and a higher quality of life (12)
<b>QUT project team</b>	Creative Industries: Dr Debra Polson; Wade Taylor; Ryan Quagliata; Bryce Christensen IFE: Sarah Quijano (ViseR)
<b>Partner organisations</b>	Queensland Art Gallery and Gallery of Modern Art (QAGOMA): Aidan Robertson, Clinton Wong, Terry Deen, Grace Liu, Amanda Slack-Smith, Michael O’Sullivan
<b>Timeline</b>	2017

### Why it matters

In May 2017, the highly anticipated *Marvel: Creating the Cinematic Universe* exhibition was held exclusively at Brisbane’s QAGOMA as a fully interactive visitor experience. Showcasing more than 500 objects including costumes, sets, props, storyboards, original comics, concept art and films, this was the largest Marvel exhibition ever presented in an art museum. Open between 27 May and 3 September 2017, the exhibition attracted an attendance of 269,816 with 97 per cent visitor satisfaction. Forty-two per cent of attendees were first-time visitors and 14 per cent travelled from interstate or overseas.

QAGOMA has a well-deserved international reputation for pushing creative boundaries and was seeking to elevate the visitor experience by including various interactive elements to enhance opportunities for immersive audience participation and engagement.

### How IFE is making an impact

In the lead-up to the exhibition, IFE researcher Dr Deb Polson from QUT’s School of Design collaborated exclusively with QAGOMA to design interactive works to give gallery visitors new kinds of novel experiences and insightful interactions with both the museum and Marvel Studio content.

The QAGOMA Marvel projects brought together expertise from across QUT in the creative industries and design, animation and visual arts, and information technology to create this engaging installation. The transdisciplinary team collaborated with gallery staff, including exhibition curator Amanda Slack-Smith, the QAGOMA design team led by Michael O’Sullivan and Head of Learning, Terry Deen.

Using content direct from Marvel Studio, QUT researchers brought complex 3D Marvel character models to life, allowing exhibition visitors to interact through several hands-on features. The research team designed virtual

mirrors that scanned visitor movements, allowing them to control life-size character models. This particular interactive work was used more than 222,850 times during the exhibition.

The research team also built on established successes with mobile app interaction, designing an app that enabled visitors to follow mobile clues, interact with movie scenes and discover artefacts from the Marvel Universe. The app challenged visitors with moral scenarios, immersing them in a collective journey to stabilise the balance of power in the universe.

A major feature of the exhibition was the Marvel Cinematic Universe Data Explorer. This unique and dynamic interface allowed visitors to explore the attributes of their favourite characters and discover the complex connections between them based on their shared powers, skills, artefacts and origins.

“QUT played an important role in bringing aspects of the exhibition to life. It’s extremely exciting to have worked with QUT on elements within the exhibition, as Deb Polson and her team are well-known internationally for creating memorable experiences with digital technologies.” – QAGOMA Marvel Exhibition Curator, Amanda Slack-Smith



Dr Deb Polson from QUT’s School of Design has collaborated with Marvel and QAGOMA to produce interactive displays at the *Marvel: Creating the Cinematic Universe* exhibition.

# Enabling platform: Intellisensing

<b>Leadership</b>	
<b>PLATFORM LEADER</b>	<ul style="list-style-type: none"> <li>• Professor Tristan Perez</li> </ul>
<b>LEADERSHIP TEAM</b>	<ul style="list-style-type: none"> <li>• Science and Engineering: Dr Matthew Dunbabin; Associate Professor Dian Tjondronegoro; Professor Duncan Campbell; Dr Erin Peterson; Dr Grant Hamilton; Professor Ian Turner; Distinguished Professor Kerrie Mengersen; Professor Jonathan Roberts; Associate Professor Tomasz Bednarz; Professor Troy Farrell; Dr Kate Devitt; Associate Professor Jim Hogan; Associate Professor Felipe Gonzalez</li> <li>• Business: Professor Paul Hyland; Dr Udo Gottlieb</li> <li>• Knowledge to Innovation Broker: Mr Raymond Johnson</li> </ul>
<b>Real-world context</b>	
<b>KEY TRENDS</b>	<p>Governments, businesses and individuals often suffer from data overload and yet lack the critical information they need to make sound decisions and address management problems. Society is also on the cusp of a revolution in the way we sense and interact with the world. Technological advances in robotics, autonomous systems, sensor networks and mobile and wearable devices are generating extraordinary volumes of data and giving us unprecedented power to extract key information that helps us understand and manage natural and built environments. This revolution will transform a wide range of industries and sectors as well as the policy-making processes of governments.</p>
<b>GRAND CHALLENGES</b>	<ul style="list-style-type: none"> <li>• Developing technologies and methods for collecting and analysing large amounts of data to increase situational awareness and gain new insights</li> <li>• Harnessing key information to make our natural and built environments more resilient, secure and sustainable (socially, economically and environmentally)</li> <li>• Designing sensing and data analysis infrastructure with economies of scale for solving management problems and making critical decisions</li> <li>• Addressing society's concerns about policy and law governing robotic and sensing technologies</li> </ul>
<b>Our research strategy</b>	
<b>IMPACTS</b>	<p>IntelliSensing is about getting intelligence from sensing. Our research focuses on methods for generating data (sensing), extracting information (intelligence gathering) and using this information to address real world challenges in the built, natural and digital environments. Our research is designed to drive the following changes in the real world:</p> <ul style="list-style-type: none"> <li>• many industries increase their productivity through IntelliSensing</li> <li>• IntelliSensing enhances decision making for triple-bottom-line (financial, social and environmental) sustainability</li> <li>• new digital-physical markets and businesses are formed.</li> </ul>
<b>FOCUSES</b>	<ul style="list-style-type: none"> <li>• Developing solutions to real-world problems by investigating how to create sensing infrastructure, robotics and autonomous systems that can understand and respond to their environments in order to augment our capacity to perceive, think and act</li> <li>• designing innovative cognitively-matched tools including visual analytics to present information so governments, businesses, citizens and consumers can more easily access and digest large volumes of data and enhance their decision making without reverting to approximate methods</li> <li>• understanding systems and system behaviours through the use of novel mathematical models and powerful data analytics</li> <li>• exploring new frontiers in optimisation and computational methods for decision and control strategies that can handle all levels of uncertainty and increased levels of autonomy</li> <li>• understanding and changing limitations of legal and regulatory frameworks to enable the wide application of IntelliSensing solutions across different sectors</li> <li>• creating programs to prepare our education sector for developing the future workforce which will develop, deploy, and disseminate IntelliSensing solutions across different sectors.</li> </ul>
<b>MEASURES</b>	<p>We are tracking the impact of our research using the following lead indicators:</p> <ul style="list-style-type: none"> <li>• the number of QUT IntelliSensing higher degree research students, research fellows and Researcher in Business staff sponsored by industry and government</li> <li>• increasing industry and government situational awareness of changing environments and tipping points</li> <li>• the number of QUT partnerships to develop commercial IntelliSensing technologies.</li> </ul>

---

## Research and impact highlights

During 2017, we drove the development of IntelliSensing projects across different sectors, with a focus on the natural environment and defence.

The successful establishment of the Food Agility Cooperative Research Centre (FA-CRC) with QUT as foundational partner showed how the efforts in **digital agriculture** at QUT led by IntelliSensing align with national and international pathways towards a better use of information to manage agrifood production systems. QUT plays a leading role in the FA-CRC research portfolio through the engagement of Professor Bronwyn Harch as Research Director and Professor Tristan Perez as Agrifood Informatics Research Program leader.

Also in the area of digital agriculture, we kicked off an ambitious project with the Cotton Research and Development Corporation (CRDC) to map the decision-making process that cotton growers face during a cropping cycle and determine information sources, uses and gaps related to these decisions. This will provide CRDC with situational awareness about current opportunities to develop low risk investment in research on digital agriculture. This project involves a joint effort by QUT researchers from Science and Engineering, Creative Industries, Law and Business.

In 2017, the Strategic Investment in Farm Robotics (SIFR) project closed, marking a shift from research to commercialisation for agricultural robotics technology developed at QUT with support from IFE. The commercialisation work is ongoing in partnership with QUT bluebox and Queensland Department of Agriculture and Fisheries through the Technology Commercialisation Fund.

Finally, we developed new data analytics, as part of a collaboration with The Yield, for inference of daily crop-water intake in horticultural crops. These analytics inform decisions for crop irrigation and efficient use of water.



**Defence** also figured very highly into IntelliSensing efforts for 2017. We progressed two projects with the Maritime Division of the Defence Science and Technology Group (DSTG) in areas of

online data analytics and motion control of underwater platforms. This informs the Australian Department of Defence in naval acquisitions. This work gave IFE the opportunity to attract overseas talent with the appointment of Dr Alejandro Donaire, who is a world leader in the area of passivity-based control of physical dynamical systems.

This work also fostered collaborations with Norwegian University of Science and Technology (NTNU) and Virginia Tech. With NTNU, IntelliSensing researchers joined forces on a new project on risk-based control to enable autonomous marine operations. With Virginia Tech and DSTG, we developed novel mathematical models that describe the changes in dynamic behaviour of submarines as they transition from fully submerged to the sea surface and manoeuvring in the seaway.

Together with QUT Science and Engineering Faculty maths and statistics researchers, we initiated two new projects with the Department of Defence on uncertainty quantification in complex dynamical systems, and analysis of complex operations in relation to future force design. This work is with the DSTG Weapons and Combat Systems Division and Joint and Operations Analysis Division.



During 2017, QUT came to the international forefront in relation to enabling factors for **aerospace autonomy**. QUT researcher Dr Aaron McFadyen broke on to the world stage by presenting his responses to a request for information by the International Civil Aviation Organization on Unmanned Aircraft System Traffic Management – a great achievement. Also in aerospace, Dr Tim Molloy started his Advance Queensland Fellowship working with Boeing on optimal control and game theory approaches to collision avoidance strategies in unmanned aircraft.

Finally, Professor Tristan Perez had the opportunity to work closely with the Acting Queensland Chief Scientist, Dr Christine Williams, assisting the Queensland Government with the successful bid that will bring the headquarters of the Defence Trusted Autonomous Systems Cooperative Research Centre to Queensland. Key aspects of Queensland's proposal stemmed from work developed by Professor Perez on frameworks for uncertainty quantification of robust autonomy.



*Professor Tristan Perez, IntelliSensing Enabling Platform Leader*



---

## Showcase events and initiatives

### Closing the Technology Loop on Self-Driving Cars: A Transdisciplinary Forum 14 June 2017



About 145 attendees from industry, government and research gathered at QUT Gardens Point to discuss the prospect of widespread self-driving cars and the challenges of merging the diverse range of technological approaches being proposed as solutions. The forum allowed participants to hear experts illustrate how these technology innovations will unfold for the many parties affected: the automotive-related industries including insurance, law, security and service providers, government, infrastructure managers and society itself, including those who are unable to drive. Speakers included QUT researchers in robotics, law and road safety and the CEO of the Motor Trades Association of Queensland.

### QUT Digital Agriculture research website

The next agricultural revolution will be driven by the use of digital technologies, informatics and cybernetics. Read more about the latest digital agriculture research at [www.research.qut.edu.au/digital-agriculture](http://www.research.qut.edu.au/digital-agriculture)

### UAV Challenge 26 – 27 September 2017



QUT and CSIRO jointly organised the annual UAV Airborne Delivery Challenge, which involved teams of high-school students developing an unmanned airborne vehicle (UAV) system to drop a medical package to a set location. In 2017, there were 27 teams registered from Australia, China, Turkey, Poland, Greece, Denmark, USA, India and Malaysia, with 20 teams selected to take part in the Queensland competition. Queensland Acting Chief Scientist, Dr Christine Williams opened the event, which had joint winners: Toowoomba Christian College and Calamvale Community College.

### Transport Main Roads showcase 11 December 2017

Researchers visited the Department of Transport and Main Roads to showcase QUT's capabilities in UAVs, autonomous vehicles, artificial intelligence, big data and the ethics and legal implications of self-driving cars. IFE's new Research Engineering Facility was also highlighted.

## Case study: QUT research supporting Australia's future naval acquisition programs

<b>Project or program title</b>	Marine platform dynamics and motion control
<b>Research theme or enabling platform</b>	IntelliSensing
<b>IFE impact alignment</b>	Enhance decision making for triple-bottom-line sustainability (14)
<b>QUT project team</b>	Science and Engineering: Professor Tristan Perez, Dr Alejandro Donaire, Dr Christina Kazantsidou, Associate Professor Jason Ford, Justin Kennedy
<b>Partner organisations</b>	Australian Department of Defence - DST Group
<b>Timeline</b>	2017 – 2020

### Why it matters

The motion of marine platforms can significantly affect crew effectiveness and mission performance. Optimised motion behaviours across a wide envelope of sailing and environmental conditions require the joint consideration of platform dynamics and motion control systems designs.

### How IFE is making an impact

QUT is working in partnership with the Australian Government's Defence Science and Technology Group (DTSG) on future technologies for motion control of sea platforms.

Marine platforms such as submarines and some underwater vehicles conduct operations close to and on the sea surface. In these modes of operation, the presence of ocean waves can significantly change the dynamic characteristics of motion. These characteristics should be captured by mathematical models used for motion control designs seeking to optimise operability.

In this project, QUT researchers are developing novel mathematical models and algorithms based on mathematical control theory to achieve high performance motion control. This research supports DTSG's work for Australia's future naval acquisition programs.

QUT researchers have been working with maritime industry and defence globally for more than 15 years in the area of ship motion control and data analytics. They have contributed to the development of commercial systems for dynamic positioning, course autopilots, roll gyro-stabilisation, crane motion compensation, ride control and model prototyping for ship training simulators.



*Marine platforms like submarines and underwater vehicles can be affected by waves when operating close to and on the sea surface. Motion control systems are a critical enabling technology for optimal operations. (Generic platform image from Royal Australian Navy).*

## Case study: Cotton production to benefit from agri-intelligence

<b>Project or program title</b>	Agri-intelligence in Cotton Production Systems
<b>Research theme or enabling platform</b>	IntelliSensing
<b>IFE impact alignment</b>	Increase productivity through IntelliSensing (13); Enhance decision making for triple-bottom-line sustainability (14)
<b>QUT project team</b>	Science and Engineering: Professor Tristan Perez, Associate Professor James McGree, Dr Erin Peterson, Dr Grant Hamilton, Dr Kate Devitt, Zoe Mellick, Dr Alan Woodley Business: Professor Clevo Wilson Creative Industries: Dr Alice Payne IFE: Professor Bronwyn Harch, Andrew Simpson
<b>Partner organisations</b>	Cotton Research and Development Corporation
<b>Timeline</b>	2017 – 2019

### Why it matters

Cotton is one of Australia’s largest rural export earners, with more than 1200 cotton farms in Australia. Cotton is a major commodity, representing 30 to 60 per cent of the gross value of the total agricultural production in the Australian regions where it is grown (Australian Grown Cotton Sustainability Report, 2014).

Across the cotton season, growers and farm managers must make a range of management decisions, which can be difficult due to the uncertainty in attributes they cannot control and also in the complexity associated with how these decisions relate to one another. This uncertainty can be mitigated through the use of information extracted from purposefully collected data. By being better informed, cotton growers will be able to improve decision-making and management practices leading to more efficient, profitable and sustainable operations.

### How IFE is making an impact

Over the next 10 years, agriculture is expected to transition even further into the digital age, realising the tremendous potential to understand better the opportunities and risks arising from data across the value chain with integrated and sustainable management operations.

In 2017, QUT researchers were funded by Cotton Research and Development Corporation to develop the first step towards agri-intelligence in cotton production systems. Agri-intelligence seeks to take the first steps leading to the integration of deep agricultural knowledge, knowledge across the value chain and systems science with powerful digital technologies. This integration is designed to help farming enterprises make the best use of agronomic, environmental and economic data.

This project aims to identify key the decisions that growers make in a cotton season—from planning and crop management to harvesting and post-harvesting—identifying information assets relevant to decision processes and determining information and utilisation gaps.

The outcomes will provide key information for Cotton Research and Development Corporation to focus future research and development investment in the area of digital agriculture, as well as providing a framework to develop such investment.



*Cotton is one of Australia’s largest rural export earners, with more than 1200 cotton farms in Australia.*

# Enabling platform: Transforming Innovation Systems

Leadership	
<b>PLATFORM LEADER</b>	<ul style="list-style-type: none"> <li>• Associate Professor Robert Perrons</li> </ul>
<b>LEADERSHIP TEAM</b>	<ul style="list-style-type: none"> <li>• Business: Dr Ozgur Dedehayir; Professor Rachel Parker; Dr Henri Burgers</li> <li>• Creative Industries: Distinguished Professor Stuart Cunningham</li> <li>• Education: Professor Mary Ryan</li> <li>• Health: Professor Neil King</li> <li>• Law: Dr Kylie Pappalardo</li> <li>• Science and Engineering: Professor Michael Rosemann</li> <li>• Knowledge to Innovation Broker: Mr Andrew Keir/Mr Raymond Johnson</li> </ul>
Real-world context	
<b>KEY TRENDS</b>	<p>The innovation system – the path from discovery to deployment – is not working as well as it could in Australia. Many businesses and organisations do not have ready access to the knowledge and skills they need to be innovators. Asset-intensive industries, such as the energy and resources sectors, are not well served by innovation research or practice, but are eager to be more innovative and increase their rate of technological change. Despite the myriad electronic collaboration tools available, distance still often stifles the innovation process within Australia, and between Australia and the rest of the world.</p>
<b>GRAND CHALLENGES</b>	<ul style="list-style-type: none"> <li>• Developing the capacity of Australian businesses and organisations to change and innovate faster, so that they remain competitive in a rapidly changing world</li> <li>• Streamlining the innovation system so that research efforts are not wasted and research breakthroughs benefit society more quickly</li> <li>• Increasing engagement between industry and the research sector in Australia</li> </ul>
Our research strategy	
<b>IMPACTS</b>	<p>Our research is designed to drive the following changes in the real world:</p> <ul style="list-style-type: none"> <li>• Australian industries have more resilient revenue streams</li> <li>• Australia focuses more research and development resources on projects that matter</li> <li>• connected innovation is no longer impeded by distance.</li> </ul>
<b>FOCUSES</b>	<p>We are investigating how to:</p> <ul style="list-style-type: none"> <li>• initiate, conduct and deliver research more effectively so that innovations can be evaluated and adopted more easily by industry, governments, and the public</li> <li>• develop university–industry relationships that generate new research opportunities and innovation pathways</li> <li>• help businesses and organisations to develop sustainable revenue streams while still experimenting, adapting and exploiting opportunities</li> <li>• change business processes, business models, industry structures and regulatory frameworks to support innovation</li> <li>• develop innovation management methods that more tightly link research programs to the needs of governments, markets and society.</li> </ul>
<b>MEASURES</b>	<p>We are tracking the impact of our research using the following lead indicators:</p> <ul style="list-style-type: none"> <li>• the median value of industry/government funded research projects to accelerate innovation</li> <li>• the number of projects with industry/government on development and evaluation of impact frameworks</li> <li>• the number of projects that contribute to the development of a geography independent innovation environment.</li> </ul>

## Research and impact highlights

IFE's Transforming Innovation Systems research theme had several key highlights during 2017.

At a strategic level, IFE Executive Director Professor Bronwyn Harch is a member of the federal government's **Innovation and Science Australia Board**, which coordinates government investment in innovation, science and research and stimulates public discussion and debate about innovation and science. Key outcomes during 2017 included the release of the Performance Review of the Australian Innovation, Science and Research System 2016 and delivery of *Australia 2030 Plan: Prosperity through Innovation*, which provides recommendations to enhance Australia's research and innovation performance.

Throughout the year, QUT researchers have been working on a **global innovation survey project** carried out with the Society of Petroleum Engineers (SPE), which has more than 120,000 international members. Led by QUT, the project was a collaboration with SPE, Texas Christian University (USA) and Erasmus University (Netherlands). This survey will deliver unique insight into approaches to innovation from different cultures and geographic regions around the world. While some literature comparing a few countries exists, this new evidence will be very valuable in helping researchers understand innovation as a global phenomenon.

Researchers are also analysing data collected as part of a large, multi-institution research project using a tool called The Lens ([www.lens.org](http://www.lens.org)) to examine the specific mechanics of how innovation happens in the energy domain ([see case study, page 37](#)).

During 2017, researchers have been **repurposing Design Structure Matrices**, a mathematical tool applied to a broad range of contexts such as logistics and manufacturing, to analyse innovation networks. This project was completed in collaboration with Texas Christian University and we look forward to publishing the results soon.

We also welcomed high-profile speakers to present IFE Distinguished Visitor Lectures on innovation-related topics including Professor Patricia Aufderheide, a visiting Fulbright Scholar from the USA, and David Sweeney, Executive Chair of Research England.

Our relationships with external partners are being strengthened through activities such as innovation sprints with Powerlink Queensland ([see case study, page 36](#)),

and the signing of a three-year agreement with CSIRO to investigate how research impact is assessed.



Associate Professor Robert Perrons

### Showcase initiatives



### O-Room encourages innovation by industry

In September 2017, QUT opened the doors of a unique tailor-made space called the O(pportunity)-Room to proactively encourage innovation by private and public organisations. Located within IFE headquarters, the O-Room is equipped with relevant design and ideation frameworks allowing researchers to help industry partners identify new action possibilities using a dedicated four-stage methodology. Based on related research, hybrid teams of QUT researchers and external stakeholders have produced a number of new strategic options. The most notable project took place with Suncorp as part of a 'Future of Banking' initiative, where Suncorp representatives worked with QUT academics over an eight-week period and presented several successful new value propositions to the Suncorp Board.

---

## Case study: The transforming power of innovation - Powerlink Queensland

<b>Project or program title</b>	Powerlink Queensland Innovation Sprint
<b>Research theme or enabling platform</b>	Transforming Innovation Systems
<b>IFE impact alignment</b>	Improved revenue resilience of Australian industries (19)
<b>QUT project team</b>	Business: Associate Professor Robert Perrons; Dr Ivano Bongiovanni
<b>Partner organisations</b>	Powerlink Queensland
<b>Timeline</b>	November 2017

### Why it matters

The important role of innovation and its connection to the long-term economic performance of organisations has been understood for quite some time. While practically every industry benefits from innovation, it tends to happen differently in different sectors.

So-called low- and medium-technology industries - including asset-intensive industries like mining, railways and energy - have proven to be sufficiently different from others as they often struggle to behave in ways that lend themselves to innovation. Asset-intensive sectors frequently continue to take decades to adopt promising innovations that are readily absorbed and applied by other sectors in a fraction of the time. The attention of policymakers and the media has been concentrated disproportionately on the 3-10 per cent of modern economies conventionally classified as high-tech, however the asset-intensive sectors that represent more than 20 per cent of the Australian economy have historically attracted considerably less attention where innovation is concerned.

### How IFE is making an impact

Providing focused assistance to asset-intensive industries has been a strategic priority for IFE's Transforming Innovation Systems enabling platform.

In 2017, IFE researchers ran a three-day innovation sprint for Powerlink Queensland to explore new approaches for managing security at its substations throughout Queensland. An innovation sprint allows organisations to develop and test new high-level ideas in an agile way that considers both challenges and opportunities.

Powerlink Queensland's role in the electricity supply chain is to transport high-voltage electricity, generated at major power stations, through its transmission grid to the commercially-owned distribution networks which supply customers. Workshop participants were tasked with

applying six ideation lenses to identify blue-sky ideas that Powerlink Queensland could use to improve substation security, but in fundamentally different ways.

This engagement helped Powerlink staff to apply new ideas and perspectives to a recurring problem and generate an innovative solution that they might not have otherwise discovered.



*An innovation sprint helped Powerlink Queensland generate ideas to improve its asset security.*

## Case study: Mapping the origins of new energy technologies

<b>Project or program title</b>	Mapping the Origins of Energy Technologies
<b>Research theme or enabling platform</b>	Transforming Innovation Systems
<b>IFE impact alignment</b>	The nation focuses resources on projects that matter (20)
<b>QUT project team</b>	Business: Associate Professor Robert Perrons; Adjunct Professor Adam Jaffe
<b>Partner organisations</b>	Motu Economic and Public Policy Research (New Zealand)
<b>Timeline</b>	2016 – 2018

### Why it matters

Climate change is widely considered to be one of the more urgent problems facing human civilisation, and there is broad consensus that the world's economic activities should increasingly shift away from carbon-intensive energy sources (eg. coal, oil, and natural gas) in favour of green/clean energy (eg. wind, solar and tidal).

While some of this transition can be achieved by switching from existing carbon-intensive energy sources to existing green technologies, the sheer scope and scale of the required change in our worldwide energy system will require significant technological breakthroughs in the energy domain.

To date, there has been limited research on how these innovations come about.

### How IFE is making an impact

IFE researchers are working with Motu Economic and Public Policy Research in New Zealand to investigate how new energy technologies originate, so pathways to innovation within the global energy sector can be understood and examined. This project is delivering impact by allowing researchers to identify the scientific fields, individuals, institutions and geographic areas that are the source of the science underlying both clean/green and traditional fossil-based inventions.

This research will help to identify:

- which countries are doing the science behind clean vs. dirty technologies, to offer insight into national systems and frameworks that have been effective in the fight against climate change

- how long it takes for academic ideas to progress to real-world innovation, as deployment of energy innovations frequently takes several decades in the energy domain as opposed to other sectors
- how open the innovation process has been, and whether tomorrow's breakthrough energy technologies are more likely to be created by large organisations or tight networks of well-connected researchers, or by a broad consortium working together in a large, loosely connected network.

To answer these questions, researchers will examine citations in patents and non-patent literature and how they are linked to authors and locations using an online platform called The Lens ([www.lens.org](http://www.lens.org)) which serves nearly all of the patent documents in the world as open, annotatable digital public goods informed by scholarly and technical literature along with regulatory and business data. Results of this study are expected in 2018.



*Understanding the origins of new energy technologies is helping to map innovation pathways in the global energy sector.*

# Enabling platform: Manufacturing with Advanced Materials

Leadership	
<b>PLATFORM LEADER</b>	<ul style="list-style-type: none"> <li>• Associate Professor Anthony O’Mullane (August 2016 – August 2017)</li> <li>• Professor Leonie Barner (appointed leader in September 2017)</li> </ul>
<b>LEADERSHIP TEAM</b>	<ul style="list-style-type: none"> <li>• Science and Engineering: Associate Professor Anthony O’Mullane; Professor Ian Mackinnon; Dr Jennifer Macleod; Professor YuanTong Gu; Professor Peter Talbot; Associate Professor Prashant Sonar; Dr James Blinco; Professor Mia Woodruff; Associate Professor Tim Dargaville; Professor Prasad Yarlagadda</li> <li>• Knowledge to Innovation Broker: Ms Michelle Gane</li> </ul>

Real-world context	
<b>KEY TRENDS</b>	<p>Past societies depended on stone or bronze or iron. Today, silicon and polymers are supporting and transforming the world. Materials science and engineering are integrating concepts and techniques from many disciplines, including chemistry, biology, physics, engineering, information sciences and mathematics. Computer modelling is combining with highly specialised lab equipment to allow precise design of advanced materials for specific purposes.</p>
<b>GRAND CHALLENGES</b>	<ul style="list-style-type: none"> <li>• Minimising the social and environmental impacts of material sourcing, manufacturing, use, recycling and disposal</li> <li>• Developing high-performance materials with diverse applications across many industries in the digital age</li> <li>• Catalysing new industries in Australia that capitalise on the country’s expertise in materials characterisation and processing</li> </ul>

Our research strategy	
<b>IMPACTS</b>	<p>Our research is designed to drive the following changes in the real world:</p> <ul style="list-style-type: none"> <li>• more efficient use of resources by global industry</li> <li>• materials have more environmentally sustainable life cycles</li> <li>• industry shares the benefits of new materials with communities</li> </ul>
<b>FOCUSES</b>	<p>We are investigating how to:</p> <ul style="list-style-type: none"> <li>• enhance the performance of materials by changing their electrical, magnetic, thermal and energy-conversion properties</li> <li>• produce higher quality coatings and films to protect or deliver devices, sensors and surfaces</li> <li>• create new industries through materials design, demonstrating feasible industrial materials production and innovative processing and analytical techniques.</li> </ul>
<b>MEASURES</b>	<p>We are tracking the impact of our research using the following lead indicators:</p> <ul style="list-style-type: none"> <li>• the median value of contracts where industry invests directly in development of materials</li> <li>• the number of requested consultations to government on materials life cycle</li> <li>• the number of unique views of QUT media related to impacts of materials on health and the environment.</li> </ul>



## Research and impact highlights

In 2017, IFE's Manufacturing with Advanced Materials Enabling Platform had a change in leadership from Associate Professor Anthony O'Mullane to Professor Leonie Barner, an eminent materials researcher who came to Brisbane after working at Karlsruhe Institute of Technology/University of Karlsruhe in Germany for the past five years. Leonie is a Principal Research Fellow in the Chemistry, Physics and Mechanical Engineering (CPME) School of the Science and Engineering Faculty.

It was a very significant and productive year for the enabling platform. In January, QUT commenced significant projects with leading Japanese manufacturer Sumitomo Electric. One of these projects centred on the installation of a **30kW demonstrator concentrator photovoltaic unit** in the Redlands area to trial and develop renewable solar energy technologies. This project has the potential to make Queensland's energy system significantly more efficient, robust and sustainable (see case study, page 42).

A milestone achievement was the creation of **Australia's first lithium-ion battery** using a purpose-built manufacturing facility at IFE's Banyo Pilot Plant Precinct, which allows industry/university researchers to test new battery technology at scale (see case study, page 41).

Another highlight for the Banyo Pilot Plant Precinct was the arrival of a **superconducting motor** as a result of a partnership with Siemens and the Defence Science and Technology Group. The motor has attracted significant attention, including a visit by Australia's Chief Scientist, Dr Alan Finkel AO in October.

In March, a research website for the Manufacturing with Advanced Materials enabling platform was launched, along with a fortnightly seminar series that allows us to share research and welcome national and international speakers to present lectures on themes such as solar energy, computational modelling, microscopy and macromolecular synthesis.

In April, the **new analytical and synthetic laboratories** of the Soft Matter Materials group headed by ARC Laureate Professor Christopher Barner-Kowollik were opened at QUT. This occasion was also marked by a symposium on 9 June featuring speakers from Australia's leading macromolecular research groups.

**Three IFE Catapult projects** aligned with the platform were funded during 2017. The first project titled *Demonstrating effective recycling of fast fashion fibres* is led by Associate Professor Rob Speight. He and his team are tackling the ongoing problem of fashion waste by developing an effective way to turn mixed and blended fabrics back to single component yarns which can then be made back into fabric.

Dr Thomas Rainey and his team will focus on *Cheaper and more effective face masks through design and paper science*, working on adapting cellulose-based material to produce a cheap, appealing, breathable and highly efficient face mask which will improve the user experience while being disposable.

Finally, a new *Design and manufacturing of gradients object* project aims to develop and integrate a user interface and 3D printer for the design and manufacture of composite objects of discrete graded composition. This research will be led by Dr Aurelien Forget and Dr Deb Polson.

The international **Nanostructures for Sensors, Electronics, Energy and Environment (NanoS-E3) Conference** was hosted at QUT Gardens Point campus from 26-29 September. Topics included 2D materials, batteries, supercapacitors and superconductors. This well-established international meeting is an excellent opportunity to foster knowledge exchanges, especially between international leaders and young scientists in the field of nanotechnology, focusing on sensors, electronics, energy and environment, and to establish fruitful collaborations in the area of material science, chemistry, physics and engineering.

The platform also supported several well-attended meetings and workshops, including the Queensland Annual Chemistry Symposium on 27 November, which gives young researchers the opportunity to present their work. Plenary talks were presented by Mary Fletcher, Sally-Ann Poulsen, Nicole Rijs and Jerome Waser.

On 12 December, the platform joined with QUT's Science and Engineering Faculty to host a workshop titled *Recent Advances in Nanomechanics – Science and Facilities*, which was well-received and attended by researchers and students from Brisbane universities.



Professor Leonie Barner,  
Manufacturing with Advanced  
Materials Enabling Platform  
Leader



Associate Professor  
Anthony O'Mullane

---

## Showcase events

### IFE Manufacturing with Advanced Materials Research Showcase

24 February 2017

The Materials Research Showcase brought together about 55 QUT researchers from diverse disciplines, including chemistry, biology, physics, engineering, information sciences and mathematics to hear more about QUT's transdisciplinary research in advanced materials. Speakers included IFE Executive Director, Professor Bronwyn Harch, Associate Professor Anthony O'Mullane and keynote speaker Professor Ian Mackinnon.

### QUT Soft Matter Materials Symposium

9 June 2017

Australia's leading polymer and soft matter materials scientists presented their current research at this symposium, attended by about 100 people and supported by IFE, QUT's School of Chemistry, Physics and Mechanical Engineering; and QUT's Soft Matter Materials Laboratory. The event was opened by then QUT Vice-Chancellor, Professor Peter Coaldrake and featured expert speakers from CSIRO and Australian universities.

### QUT Materials Science and Engineering research website

Materials science and engineering integrates concepts and techniques from many disciplines, including chemistry, biology, physics, engineering, information sciences and mathematics. Read more about the latest materials science and engineering projects at QUT at [www.research.qut.edu.au/msae](http://www.research.qut.edu.au/msae)

While past societies depended on stone or bronze or iron, today, silicon and polymers are supporting and transforming the world. Materials science and engineering investigation has to characterise and analyse existing materials and to design and optimise new materials. Materials science and engineering integrates concepts and techniques from many disciplines, including chemistry, biology, physics, engineering, information sciences and mathematics.

In QUT's Science and Engineering Faculty there are three broad areas of materials research - nanomaterials, surface engineering and molecular materials.

This research is supported by the Institute for Future Environments (IFE) focus on manufacturing with advanced materials, which aims to bring transdisciplinary researchers, industry and government together to discover and design more efficient and sustainable materials for diverse applications.

QUT offers specialist facilities, including the IFE Central Analytical Research Facility (CARF) for materials characterisation and IFE Design Pilot Plant Facility for large scale engineering research. Computer modelling is also combined with highly specialised 3D equipment to allow precise design of advanced materials for specific purposes.

[What we do](#) | [Projects](#) | [People](#) | [Partners](#) | [Newsroom](#) | [Contact](#)

[Accessibility](#) | [Copyright](#) | [Disclaimer](#) | [Privacy](#) | [Rights Information](#)

©2000-16. 000131 / ISBN 978 0 701 729432

## Case study: QUT creates Australia's first lithium-ion battery

<b>Project or program title</b>	Lithium-ion battery pilot facility
<b>Research theme or enabling platform</b>	Manufacturing with Advanced Materials
<b>IFE impact alignment</b>	Global industry using advanced materials are more resource efficient (16)
<b>QUT project team</b>	Science and Engineering: Professor Peter Talbot; Professor Jose Alarco; Dr Jawahar Nerkar; Josh Watts; Mark Quinlan; Felix Lo IFE: Banyo Pilot Plant Precinct
<b>Partner organisations</b>	Auto Cooperative Research Centre; Malaysia Automotive Institute
<b>Timeline</b>	Ongoing

### Why it matters

New technologies often demand more compact, higher capacity, safe, rechargeable batteries. Lithium-ion batteries represent a huge step forward, with lithium being one of the lightest elements in the periodic table and having one of the largest electrochemical potentials. This combination produces some of the highest possible voltages in the most compact and lightest volumes. Today, lithium-ion is the fastest growing and most promising battery chemistry.

### How IFE is making an impact

In 2017, QUT researchers produced Australia's first lithium-ion battery after establishing the country's only facility capable of such manufacturing at Banyo in Brisbane's north. The Australian-first battery is the outcome of a three-year \$4 million project, funded by the Auto Cooperative Research Centre and conducted in conjunction with the Malaysia Automotive Institute.

The research, led by Professor Peter Talbot, could be used to kickstart a commercial lithium-ion battery manufacturing industry in Australia, with the batteries being one of the most popular types of rechargeable batteries used in portable electronics from mobile phones to power tools and drones.

The technology and processes developed at QUT as part of the project are suitable for use by any commercial battery manufacturing company, with customised batteries now able to be developed for specific commercial applications. The process could be automated to enable Australia to have a competitive advantage in a manufacturing space currently dominated by China, and could also add value to the lithium mining industry as miners could have their materials validated at the plant.

Professor Peter Talbot has been awarded a Queensland Government Advance Queensland Founder's Fellowship to continue research and development and translate it into practical commercial outcomes.

### Research infrastructure for the real world

QUT developed Australia's first pilot facility to produce commercial grade lithium-ion batteries at the Banyo Pilot Plant Precinct. The batteries produced are the same format as those used to power Tesla cars. It is Australia's only purpose-built facility capable of such production, with the nation's only low humidity electro-manufacturing dry rooms. QUT has developed processes to produce lithium-based powder to make extremely safe and efficient batteries. The facility can rapidly prototype new battery formulations and cell types. Researchers in IFE's Central Analytical Research Facility also have the capability to analyse the properties of materials, using world-class scientific instruments.



Professor Peter Talbot and his team at QUT's pilot plant facility at Banyo have manufactured Australia's first lithium-ion batteries.

## Case study: Launch of new solar technology trial in Queensland

<b>Project or program title</b>	Concentrated Photovoltaic Solar Tree
<b>Research theme or enabling platform</b>	Manufacturing with Advanced Materials
<b>IFE impact alignment</b>	Industry shares equitably the benefits of new materials with communities (18)
<b>QUT project team</b>	IFE: Professor Ian Mackinnon; Michelle Gane; Dirk Lesner; Dr Fanny Boulaire Finance and Resource Planning: Geoff Woods Technology, Information and Library Services: Matthew Hodgett
<b>Partner organisations</b>	Sumitomo Electric Industries; Queensland Department of Agriculture and Fisheries; Trade and Investment Queensland Japan
<b>Timeline</b>	Ongoing

### Why it matters

Providing the right energy mix is a global challenge, but also a key issue for Queensland, particularly in regional parts of the state. Due to the finite nature of fossil fuels including oil, gas and coal, investigating renewable energy sources such as wind and sunlight is critical.

Solar energy represents a reliable, stable power source for Australia's energy future. With technology advancing at an unprecedented pace, research is needed into emerging energy systems and how to apply new technologies from global leaders into Australia.

### How IFE is making an impact

QUT has joined with leading Japanese manufacturer Sumitomo Electric Industries to trial and develop new renewable energy technologies with the potential to make Queensland's energy system more efficient, robust and sustainable.

On 25 January 2017, QUT researchers and representatives from Sumitomo Electric Industries visited the Queensland Government's Redlands Research Facility to celebrate the installation of a demonstrator concentrated photovoltaic (CPV) system in Queensland. The powerful new 'solar tree', unveiled by then QUT Vice-Chancellor Professor Peter Coaldrake, is being demonstrated for the first time in Australia.

The solar tree is being operated and tested by QUT researchers over a three-year period to validate detailed performance characteristics in a multi-disciplinary, multi-user field station environment. For Sumitomo Electric Industries, this demonstration installation is the first of many new energy technologies that may find a viable home and rapid take-up in Australia.

Although the CPV panels look similar to traditional photovoltaic panels, CPV technology is about 2.5 times more efficient due to a layer of lenses over the top of

the compound semiconductor photovoltaic cells that concentrates the sunlight, while precisely tracking the sun across the horizon.

This partnership will complement and boost QUT's existing renewable energy research program, which incorporates a micro-grid facility at QUT Gardens Point campus. These capabilities allow us to model and test different configurations of power systems incorporating renewable energy sources and distributed storage.

The solar tree is now the focus of a research and development proposal aimed at combining CPV technology with battery storage to develop a hydrogen production capability using water electrolysis. This extension of solar power technology to generate highly efficient, clean energy from renewable sources is taking our researchers firmly down the path of the future hydrogen economy. CPV technology combined with battery storage and production of hydrogen for use in fuel cell vehicles promises to be a crucial part of the future energy mix in Australia and around the world.



*Then QUT Vice-Chancellor Professor Peter Coaldrake celebrating the installation of the concentrated photovoltaic solar tree at the Redlands Research Facility with Sumitomo's Dr Junji Itoh.*

# CROSS-ORGANISATION RESEARCH INFRASTRUCTURE

IFE hosts six state-of-the-art research facilities that enable research discoveries across QUT and provide real-world solutions for our external partners.



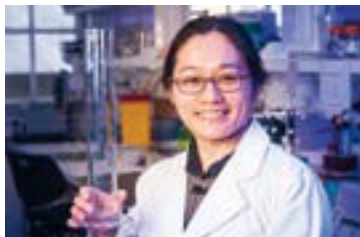
## Research infrastructure highlights

IFE hosts diverse research infrastructure capabilities, encompassing expertise in digital data and e-research; characterisation, analysis and 'omics'; prototyping and fabrication; and environmental systems and monitoring. Our research infrastructure plays a vital role in supporting research on a scale beyond the reach of individual research groups or disciplines. Our research infrastructure specialists work closely with researchers and clients to identify and implement the best solutions to real-world problems.

In 2017, IFE's research infrastructure included:

- Central Analytical Research Facility (CARF)
- Visualisation and e-Research (ViseR)
- Research Engineering Facility (REF)
- Banyo Pilot Plant Precinct
- Samford Ecological Research Facility (SERF)
- Mackay Renewable Biocommodities Pilot Plant.

# Central Analytical Research Facility (CARF)



CARF empowers researchers to access, understand and engage with advanced analytical technologies. These technologies facilitate the characterisation of materials and molecules - both human-made and naturally occurring. CARF's main users are QUT research students and staff, making CARF a key 'engine room' of the university's science research activities. Technology specialists within CARF are also advancing the capabilities of instrumentation to enable new discoveries and drive efficiencies in data collection.

## FAST FACTS

- 379 QUT clients (students and staff) trained in the use of advanced analytical equipment
- 470 consultancies and service analytical projects undertaken for 168 unique clients across 78 different entities (60 industry/7 government/11 universities)

## Research highlights and facility upgrades

- A fully refurbished, world-class, low-vibration nanoscale imaging laboratory space for operating CARF's helium ion microscope and ultra-high vacuum scanning probe microscope opened in M Block at QUT Gardens Point. This equipment is capable of generating high-quality images with atomic resolution.
- An X-ray photoelectron spectrometer, the first of its kind in Australia, was commissioned in May 2017. This has had an immediate impact on research at QUT with more than 40 users trained to use this technology within its first three months of operation.
- Collaborations between QUT and external researchers were formed due to the installation of Queensland's first Pacbio Sequel genome sequencer in CARF's genomics laboratory.
- Thermo Fisher Scientific renewed its proof-of-concept laboratory agreement that provides ongoing access and training for the QUT research community using state-of-the-art chromatography and mass spectrometry equipment (valued at more than \$2 million) located within CARF laboratories.
- CARF researcher Dr David Marshall received a travel grant to present his research on mass spectrometry development at the Borstel Lipids Symposium in Germany, and to conduct experiments at the University of Maastricht in the Netherlands and Thermo Fisher Scientific Research Facility in Germany.
- CARF Analytical Laboratory Coordinator Dr Sunny Hu received the 2017 Carolyn McKinlay award from the Australian and New Zealand Society for Mass Spectrometry, which supported her to travel to the biennial

conference in Adelaide to present her research titled *Direct Analysis of Methyl Nitrate using Selected Ion Flow Tube Mass Spectrometry*.

- Led by Professor Nunzio Motta, QUT secured an ARC Linkage Infrastructure, Equipment and Facilities (LIEF) grant to purchase a next-generation plasma dual-beam microscope within CARF. This will allow significant advances across a variety of fields including material sciences, engineering and geology.

## Engagement and outreach

- **IFE's Science in Focus Image Competition** celebrates the most beautiful, unexpected and complex images representing important QUT scientific research. More than 120 original images were entered by QUT students and staff. A finalist exhibition and award ceremony was held on 27 October 2017. Steven Charlesworth won for his photograph capturing the movement of a virus along the veins of a plant using fluorescent protein under UV light.
- **14th Biennial Australian Microbeam Analysis Symposium (AMAS)** was hosted at QUT from 6-10 February 2017. The symposium aims to advance knowledge of microanalysis techniques used to investigate materials in diverse areas of biological, materials, medical and physical sciences. Guest speakers included renowned glass authority, Andy McConnell from BBC's Antiques Roadshow.
- CARF hosted a major delegation from the **Queensland Police Service** which uses analytical capabilities and expertise of CARF staff in forensic investigations.
- After 48 years of dedicated service to QUT, the outstanding contribution that **Bill Kwiecien** has made to both the university and the science community was acknowledged by 90 staff, family members and friends at a retirement celebration on 9 June.
- **Robotronica** - IFE participated in QUT's Robotronica event by offering the general public tours of CARF laboratories and operating a popular science selfie booth.



---

## Visualisation and eResearch (ViseR)



ViseR and The ViseR Lab (Skunkworks), located on QUT Gardens Point campus, provide capability and resources to research and consultancy services around:

- development of data visualisation and interactive software interfaces
- integration of statistical and computational models and simulations
- design and development of integrated IT and AV technology solutions
- concept development, user experience design and digital transformation strategy development.

### Research highlights and facility upgrades

- A unique crowd-sourcing solution for monitoring reef health was designed and developed by ViseR using online and virtual reality (VR) tools. The *Monitoring Through Many Eyes* project visualised results from complex models to provide researchers with improved assessments of coral health, water quality and impacts of human activities.
- Supporting research led by ecologist Dr Grant Hamilton, ViseR delivered BioSpark, a spatial data visualisation tool for government agencies to improve on decisions and responses to biosecurity threats.
- ViseR developed technology demonstrators for community wellness assessment, as well as senior living programs for research by Professor Laurie Buys.
- The next generation of ViseR's interactive spatial data visualisation platform, MyGlobe, was completed. In collaboration with QUT researchers, the team created a tool to link modelling tools to a rich-media interactive software interface. This tool improves on the hugely successful Cube Globe platform that has already provided industry and government with novel ways to engage customers, stakeholders and communities in complex and controversial topics.
- A key project was the Queensland Government's Spatial Innovation Hub at the Land Centre in Woolloongabba. The Spatial Innovation Hub will be the centrepiece facility for government to engage industry and academia in the opportunities of spatial industries over the long term. ViseR delivered features including large-scale interactive displays, virtual reality (VR), augmented reality (AR) and collaboration systems.
- ViseR completed the Digital Transformation Compendium for the Queensland State Archives – a concept and user experience design publication to drive its local and regional digital engagement program. This work will continue in 2018.
- Facility upgrades in 2017 included installation of new large-scale display hardware, upgraded VR and AR systems and refreshed touch interactive displays.

### Engagement and outreach

- ViseR has continued close collaboration with Seqwater to extend its education and community engagement program. We showcased our AR Sandpit at the Ekka, providing a hands-on lesson on how water catchments work to hundreds of visitors by combing VR with a traditional sandbox. The team look forward to expanding this endeavour through 2018.



- ViseR regularly hosts corporate and government VIPs to demonstrate IFE's capabilities in the digital domain. Key visits were from Suncorp executives leading innovation and digital transformation in retail banking; Great Barrier Reef working groups; Queensland Police; Snowy Hydro Limited and the IFE Advisory Committee.
- ViseR is always exploring opportunities to launch research and development outcomes into sustainable business models, enabled by the engagement of strategic partners. ViseR signed its first Engagement Globe partner, WaterSecure, returning immediate engagement with new organisations and research centres.

# Research Engineering Facility



Celebratory confetti cannons were fired at the REF launch by IFE Executive Director Bronwyn Harch, Research Infrastructure Director Sach Jayasinghe and REF Manager Andrew Keir.

## Research Engineering Facility launch 16 November 2017

IFE celebrated the launch of its Research Engineering Facility (REF) with QUT experts in robotics, computer science, design, engineering, big data analytics and autonomous systems as well as representatives from government, defence and industry organisations specialising in unmanned aircraft and engineering software. The morning program included drone and payload displays, expert presentations and networking.

## About REF

REF has a broad range of capabilities, encompassing specialist programmers, designers, engineers, pilots and project managers complemented by supporting infrastructure assets. REF also encompasses QUT's expertise in remote sensor technologies and autonomous systems, including remotely piloted aircraft systems (RPAS). This builds on QUT's expertise previously held within the Australian Research Centre for Aerospace Automation, which ceased operation in January 2017.

REF provides cross-organisational research engineering services such as design, systems integration, data collection and data management and processing. The facility supports research and development across academic, government and industry sectors and seeks external engagement in commercial and collaborative capacities focused on delivering technical solutions.

Facility staff are located at QUT Gardens Point campus and the Da Vinci Precinct at Brisbane Airport. The Da Vinci Precinct is especially relevant to QUT's aerospace automation research activities, with specialist capabilities in aircraft simulation and a testing laboratory, avionics development area, general workshop, indoor flying area and open-plan office space.



Specialist technician Gavin Broadbent from REF with an RPAS.

## FAST FACTS

- Number of RPAS flights: 230
- Time in air: 2424 minutes
- Data captured: 1.72Tb
- Distance travelled: 8196km
- Manta rays found: 1

## Research highlights

- In February, REF undertook a joint operation with Australian Institute of Marine Science (AIMS) to conduct aerial surveys of the Great Barrier Reef. Hyperspectral and ultra HD aerial surveys were augmented by AIMS underwater surveys to measure and quantify the condition of large coral reefs.
- REF undertook a RPAS survey and data analysis of vineyards for a Plant Biosecurity CRC project to enable early detection of *phylloxera*, a pest which has the potential to decimate the Australian wine industry.
- In a project with the CRC for Spatial Information and Ergon Energy, REF designed and integrated RPAS sensor payload to enable automated detection of powerlines and prevent operator-initiated collisions during maintenance and inspection.
- REF is supporting an \$8 million Design Robotics Project funded through the Innovative Manufacturing CRC and industry leader Urban Art Projects by providing software engineering capability to develop vision-enabled, adaptable robots to make high-value products that open export opportunities and create more Australian jobs.
- Other projects during 2017 included:
  - commissioning of the Sumitomo Concentrated Photovoltaic Test Plant and sustaining data logging and ICT architecture
  - experimental validation of proposed methodology for quantified parameters as part of safety-case to the Civil Aviation Safety Authority for multi-RPAS operations
  - koala detection projects using RPAS and thermal cameras
  - taking air quality measurements using RPAS next to Brisbane's M1 Motorway for research by QUT, Hanyang University and University of Barcelona.
- During 2017, REF upgraded its RPAS systems and acquired its own Pepper robot.

## Outreach and engagement

- REF participated in several events including QUT Robotronica, Avalon Airshow, World of Drones Congress, UAV Challenge, QFES Mini Expo and Australian Youth Aerospace Forum.



## Banyo Pilot Plant Precinct



The Banyo Pilot Plant Precinct is located in Brisbane's northern suburbs in an industrial precinct, and consists of two warehouses with specialised labs, workshops and large-scale engineering infrastructure. It facilitates structural, mechanical and electrical testing, geological analysis, aquaculture, and product testing and validation which require heavy engineering equipment and spaces. The facility undertakes research involving the development of pilot equipment and processes as well as long-term monitoring of industrial products. The main users of the facility are postgraduate students and academics from QUT's Science and Engineering Faculty and Centre for Tropical Crops and Biocommodities (CTCB).

### Research highlights

- An Advance Queensland Research Fellowship was awarded to CTCB researcher Dr Kameron Dunn to design and test a continuous pilot high-temperature liquefaction reactor at Banyo, in partnership with NilWaste Energy.
- In the 2017 round, QUT was successful in securing an ARC Linkage Infrastructure, Equipment and Facilities (LIEF) grant, led by Professor David Thambiratnam, that will develop a novel impact testing facility at the Banyo Pilot Plant. The impact testing facility will enable research into civil and mechanical structures, leading to component rational design philosophies and effective retrofitting of high-risk buildings, infrastructure and armoured vehicles.
- A Battery Fabrication Dry Room Facility was constructed and commissioned in March 2017. This two-room containment facility achieves class ISO 6 cleanliness and relative humidity of less than 0.5 per cent, and is equipped to produce industry-standard 18650-type lithium-ion batteries.

### Engagement and outreach

- On 24 October, Australian Chief Scientist Dr Alan Finkel AO visited QUT's Banyo Pilot Plant Precinct. He was particularly interested in the lithium-ion battery manufacturing and applied superconductivity facilities at Banyo. Dr Finkel has since linked IFE and Professor Peter Talbot (who leads the lithium-ion battery research), through the WA Chief Scientist, to emerging efforts in WA on aligned activity.
- During 2017, the facility also received visits from Deputy and Science Director of CSIRO Manufacturing, Dr Cathy Foley, the Electric Energy Society of Australia Qld Chapter and the National Association of Steel Framed Housing.



*Professor Peter Talbot (left) and Australian Chief Scientist Dr Alan Finkel AO at Banyo Pilot Precinct.*

---

## Samford Ecological Research Facility (SERF)



The Samford Ecological Research Facility (SERF) is a 51-hectare property located in the Samford Valley, west of Brisbane. The property was generously bequeathed to QUT by renowned Queensland entomologist Dr Elizabeth Nesta Marks AO. Seventy per cent of the SERF property is covered with vegetation, which provides refuge to native plants and animals under increasing pressure from urbanisation. IFE manages the use of SERF for research, teaching and learning programs. SERF is a unique facility that gives QUT researchers and students opportunities to investigate the climate, environment, soil, water, vegetation and wildlife of a peri-urban ecosystem.

### Research highlights

- As part of SERF's involvement in the Terrestrial Ecosystem Research Network (TERN), regular ecological monitoring was undertaken to collect environmental data about carbon dioxide levels and water flux using the onsite OzFlux Station and weather monitoring station.
- Ongoing monitoring of the property using vegetation and fauna surveys continued, and fauna surveys of bird species was undertaken by a postgraduate student.
- SERF's three insect enclosure screenhouses were extensively used by QUT researchers to study fruit fly behaviour and ecological and behavioural aspects of the wasp *Diachsmimorpha kraussii*.
- More than 650 QUT students from environmental sciences, biological sciences and engineering took field trips to SERF to study the soil, animals, plants and insects, and to build skills in planning for sustainable urban development.

### Outreach and engagement

- On 9 November, about 60 Samford residents and stakeholders attended the annual SERF information session to hear about the research, education and outreach activities conducted at SERF during the year. Speakers included Distributed Sites and Infrastructure Manager Dr Juan Cooper, Site Technician Marcus Yates, Dr Fernando Vanegas Alvarez, who talked about the use of remotely piloted aircraft systems (RPAS) on the property, and postgraduate student Aead Abdelnabi who presented his fruit fly behaviour research. Visitors viewed media segments from ABC TV News and *Scope* on research into myrtle rust and eco-acoustics. An artwork of the historic Barracks building was also donated by Anne and Peter Clarke.
- SERF hosted members of the Queensland Bushfood Association in March, who toured the property and discussed native plants, their properties and uses.

---

## Mackay Renewable Biocommodities Pilot Plant



The Mackay Renewable Biocommodities Pilot Plant has infrastructure and expertise to facilitate the conversion of agricultural plant waste into renewable transport fuels (bioethanol), green chemicals and other high-value biocommodities. The pilot plant is the sole provider of this capability in Australia and is based on the site of the Racecourse Mill sugar factory in Mackay. Operating at the pilot scale allows for product and process innovation to link explicitly with commercial viability assessment.

### Research highlights

- The facility hosted six academic research projects from Centre for Tropical Crops and Biocommodities (CTCB) involving pre-treatment of bagasse and cane trash biomass materials for conversion into more valuable food, feed, fibre, fine chemical and fuel products.
- One academic research project from CTCB involved fermentation of *Mortierella* fungus for bio oil production.
- In January, the facility gained eight new workstations and a new meeting room.

### Outreach and engagement

Visitors to the facility during 2017 included:

- Queensland Minister for the Environment, Great Barrier Reef, Science and Arts, Leeanne Enoch
- Australian Government Department of Agriculture and Water Resources and Harjeet Khanna from Sugar Research Australia (13 February)
- Department of Natural Resources and Mines (16 May)
- Nissan Japan representatives (15 June)
- Australasian Bioenergy and Bioproducts Symposium participants (18 October).

# TRANSDISCIPLINARY RESEARCH CULTURE AND SUSTAINABILITY

Critical to IFE's success is our research support capabilities including communications, knowledge to innovation brokering, financial and project management and legal, contracting and research administration.



# Engagement and outreach

## Events

We engage with industry, government, research organisations and the general public to share our research discoveries and understand the challenges they face. We are proactive in generating opportunities to share our research through lectures and special events.

### Grand Challenge Lecture Series



IFE's successful Grand Challenge Lecture Series explores the major challenges confronting humanity in the 21st century and the possible solutions to them. This popular series has now been running for five years, having been introduced in 2013.

In 2017, IFE presented 10 lectures by eminent speakers on a wide range of topics, including robotics, the future of work and the value of art to science. A highlight of this year's series was a lecture by then QUT Vice-Chancellor, Professor Peter Coaldrake, on 11 August, followed by refreshments in The Cube. Over the year, the lectures reached more than 2200 people (including via livestream), comprised of a diverse mix of QUT staff, stakeholders from industry and government, researchers from other universities and the general public.

Grand Challenge Lecture	Speaker
1. Can Leaders Make a Difference to Organisational Performance?	Prof Andrew Pettigrew (Oxford University)
2. Genomics and the Future of Medicine	Prof Matt Brown (QUT)
3. The Converging Insecurities of Food, Water, Energy and Climate, and their Implications for Development Aid and Research	Andrew Campbell (Australian Centre for International Agricultural Research)
4. Future Capable: Learning for Life and Work in the 21st Century	Assoc Prof Ruth Bridgstock (QUT)
5. Changing Coasts and Oceans: Science Meeting Global and National Challenges	John Gunn (Australian Institute of Marine Science)
6. Opportunities and Challenges in Robotics	Dr Henrik Christensen (Institute of Contextual Robotics, UC San Diego)
7. Going for the Higher Fruit: Universities Post Peak Public Funding	Prof Peter Coaldrake (then QUT Vice-Chancellor)
8. The Future of Skills	Dr Hasan Bakhshi (Creative Economy in Policy and Research, Nesta)
9. Superconductivity: Has It Touched Your Life?	Dr Cathy Foley (Science Director and Deputy Director Manufacturing, CSIRO)
10. The Value of an Arts-Science Nexus	Prof Graham Baker (President, Queensland Academy of Arts and Sciences)

## Distinguished Visitor Lecture Series

In 2017, IFE hosted 27 lectures in its Distinguished Visitor Lecture Series, which gives experts from academia and industry a forum for discussing key trends, issues and opportunities in their fields. Each of the 2017 lectures, which covered a diverse range of topics linked to IFE's research themes and enabling platforms, were attended by 43 people on average.

Distinguished Visitor Lecture	Speaker	IFE theme, platform/facility
1. RoBi-x Innovation Program: A Path to International Markets for Australian Robotics Innovation	Claus Risager (Blue Ocean Robotics)	IntelliSensing
2. Forests and Biorefineries	Dr Elspeth MacRae (Scion, New Zealand)	Growing the Global Bioeconomy
3. Increasing Molecular Coverage in Complex Biological and Environmental Samples Using Ion Mobility-Mass Spectrometry	Dr Erin Baker (Pacific North-West National Labs, USA)	Central Analytical Research Facility
4. What Can Plant Science Do for Human Health?	Prof Cathie Martin (John Innes Centre, UK)	Growing the Global Bioeconomy
5. A Multilevel Bayesian Approach for Modelling the Time-to-Serve in Professional Tennis	Prof Jim Albert (Bowling Green State University, USA)	Joint IFE/ACEMS lecture
6. Static and Dynamic Bioinspired Self-Assembled Material Systems	Prof Andreas Walthner (Albert-Ludwigs-University, Germany)	Manufacturing with Advanced Materials
7. New Frontiers in Atom Probe Tomography	Prof Julie Cairney (The University of Sydney)	Central Analytical Research Facility
8. Nano electrospray charge reduction differential mobility analyser; a versatile tool for characterization of aerosolised nano(bio)particles	Prof Guenter Allmaier (Vienna Institute of Technology, Austria)	Manufacturing with Advanced Materials
9. New Forms of Autonomous Transport for Urban Environments	Tommaso Gecchelin (NEXT Future Transportation Inc, Italy)	IntelliSensing
10. Light Harvesting using Emissive Aggregates	Dr Wallace Wong (University of Melbourne)	Manufacturing with Advanced Materials
11. Extraordinarily High-Strength Nanostructured Titanium Alloys for Biomedical Applications	Prof Cuie Wen (RMIT University)	Manufacturing with Advanced Materials
12. Creative Innovation and Copyright: Does Australian Policy Encourage Self-Censorship in a Digital Era?	Prof Patricia Aufderheide (American University)	Transforming Innovation Systems
13. Translational Mass Spectrometry: Molecular Images Towards Precision Medicine	Prof Ron Heeren (MultiModal Molecular Imaging Institute, Maastricht University)	Central Analytical Research Facility
14. Lethal Autonomous Robots and the Plight of the Non-Combatant	Prof Ron Arkin (Mobile Robot Laboratory, Georgia Tech)	IntelliSensing
15. Deep Reinforcement Learning in the Real World	Raia Hadsell (Google Deepmind)	IntelliSensing
16. Photovoltaic Renewable Energy Systems	Prof Masakazu Sigiyama (University of Tokyo)/ Prof Kensuke Nishioka (University of Miyazaki)	Manufacturing with Advanced Materials
17. Why the Humanoids We Love Aren't the Robots We Really Want	Andra Keay (Silicon Valley Robotics)	IntelliSensing
18. The Delicate Tension of Digital Technology	Prof Jan Recker (QUT Business School)	Transforming Innovation Systems
19. Road Vehicle Automation: History, Opportunities and Challenges	Dr Steven E Shladover (UC Berkeley)	IntelliSensing
20. Alternative Fuel Use in the US Military: The Great Green Fleet and Beyond	Adjunct Prof Chris Tindal (QUT Centre for Tropical Crops and Biocommodities)	Growing the Global Bioeconomy
21. Towards Open Urban Platforms: How Smart City Services Benefit from Urban Data	Prof Lutz Heuser (CEO [ui!] Group, Germany)	Infrastructure for Sustainable Communities
22. Global Food System Instability as a National Security Concern: An Update from the United States	Prof Molly Jahn (University of Wisconsin-Madison, USA)	Growing the Global Bioeconomy
23. Modelling the Sustainability and Productivity of Bioenergy Crops in the US and Australia	Prof William Parton (Colorado State University, USA)	Managing for Resilient Landscapes
24. Secure Deduplication and Cloud Storage	Adjunct Prof Colin Boyd (Norwegian University of Science and Technology)	Embracing the Digital Age
25. Universities and Their Relationship with Government	David Sweeney (Research England)	Transforming Innovation Systems
26. Hidden Hunger - Solutions Based on Science and the Human Experience: Lessons for Food Security in Australia	Mariana Chilton (Drexel University, USA)	Growing the Global Bioeconomy
27. (Process) Mine Your Own Business: But Do It Right!	Adjunct Prof Wil van der Aalst (Technische Universiteit Eindhoven, The Netherlands)	Embracing the Digital Age

# Research/entrepreneurship events

## IFE Engaging Industry and End Users for Research Masterclass

IFE's Knowledge to Innovation Director, Dr Mark Gibbs ran a masterclass to train researchers how to develop fundable research, interact with industry partners and meet QUT requirements. The training was held over three sessions in June and August, with each session attracting almost 50 people. A masterclass was also conducted with researchers from QUT's Institute for Health and Biomedical Innovation on 20 November.

## Übercamp: A Masterclass on How to Change the World 1–2 June 2017

Twenty of QUT's brightest students and early-career researchers converged on Twin Waters Resort, Sunshine Coast to attend the university's third annual Übercamp, a joint initiative of IFE and QUT bluebox. The event is a two-day masterclass in refining and pitching entrepreneurial ideas to expert judges and potential investors. Übercamp was facilitated by QUT bluebox chairman, biotech pioneer and former Queensland Chief Scientist Peter Andrews, and science and innovation policy analyst Fiona Wood. Guest speakers included Nano-Nouvelle CEO Stephanie Moroz, who has developed and commercialised nanotechnologies, and Audeara co-founder Dr James Fielding, whose Brisbane start-up invented headphones that use an in-built hearing test to perfectly adapt what you hear to your audio profile. This year's winning pitch was delivered by QUT Science and Engineering postgraduate student Omar Abdelrahman with his idea to create a virtual reality experience for genome sequencing to allow people to tell the story of their genes to medical professionals, family and friends.



## QUT STEM for Schools program

IFE played a key supporting role in the STEM for Schools program run by the QUT Marketing and Communication Department. For the second year in a row, IFE hosted students within the Central Analytical Research Facility (CARF) as part of the QUT High School Research Internships program. This exclusive week-long program accepted 24 of the state's top Year 12 science students to work under the mentorship of QUT scientists. Six students worked in CARF's laboratories, undertaking advanced science and engineering research. The students worked alongside IFE's Dr Jamie Riches, Dr Kevin Dudley and Dr David Marshall contributing to their research work in optical and electron microscopy, mass spectrometry and genome sequencing.



'I really enjoyed having an experience in an actual research facility and seeing all the projects and researchers collaborate... I feel like I have a much better understanding of what I would be getting into if I was to choose a career in research.' Year 12 student, Genetics Research Group



IFE continued its ongoing support of the QUT Vice-Chancellor's STEM Camp in 2017, which gave 160 high-achieving Year 11 students from across Queensland the opportunity to work for a week with QUT staff on research projects addressing some of the grand challenges faced by society in this century. Several of the projects were developed and run in IFE facilities by IFE researchers, with students being exposed to a broad range of technologies and topics, such as robotic vision, drone technology, biofabrication and hospitals of the future, water engineering, biometrics and gamification, astrophysics exploration and forensic health sciences.

During 2017, more than 1500 students, teachers and parents toured the IFE and the Science and Engineering Centre as part of STEM for Schools workshops and events, promoting QUT's unique strengths in science and engineering and celebrating its research achievements.

## World Science Festival

QUT was a major academic partner of the 2017 World Science Festival held in Brisbane from 22 to 26 March. The World Science Festival is an annual public STEM event that explores and celebrates science and art through a curated program of thought-provoking conversations, theatrical and cinematic experiences, interactive workshops and engaging demonstrations. In 2017, more than 182,000 attendances were recorded. IFE researchers were involved in sharing their expertise across the program in areas including robotics, autonomous driving, and science and arts including through QUT's Street Science display.

During 2017, a wide variety of local, national and international media outlets ran stories about IFE researchers, projects and events. Three of the major stories are described below, and some of the other media highlights from 2017 are listed in the table.

## Top stories for 2017

### Food Agility CRC: QUT to help transform Australia's food systems

In March, it was announced that QUT would play a key role in shaping the future of Australia's food system, thanks to a new \$210 million Food Agility Cooperative Research Centre (CRC). IFE's Executive Director, Professor Bronwyn Harch was appointed to the Strategic Investment Council to help lead the digital transformation of Australia's food and agricultural industry to connect food producers, processors and retailers to each other and the data they need to run their businesses more efficiently, profitably and sustainably. The Food Agility CRC and Professor Harch made the news on ABC Rural, ABC Country Hour, ABC Goldfields, Zdnet, Food Processing, APN regional newspapers, *Get Farming* and *StartupDaily*.

### QUT develops golden bananas high in pro-vitamin A

World-first QUT research that has produced a golden-orange fleshed banana rich in pro-vitamin A received extensive global and local media coverage. Led by Distinguished Professor James Dale, the decade-long research project to create genetically modified, vitamin-enriched bananas and how it will benefit African children was featured on ABC online, ABC radio and ABC TV. The story was picked up by Newsweek, AAP, 9 News, BBC News, SBS, 4BC, Yahoo 7 News, *The Daily Telegraph*, *Brisbane Times* and other Fairfax titles, *The Courier Mail* and other News Limited publications, the *Daily Mail*, PNG's *Post Courier*, and the *Otago Daily Times*. The work also made headlines in *Techly*, *NZ Herald*, *Yahoo! News UK*, *Food & Beverage*, *Axios*, *Free Republic* and *Innovation Toronto*, and the Newsweek story made the front page of Reddit. It also ran locally in *Campus Morning Mail*, *Daily News*, *Australian Geographic*, *MyExpress*, *Australian Food News*, and across the APN newspaper and Macquarie radio networks. The IFL Science website also published the research, with more than 28,000 shares, 17,000 likes and 1400 comments. The IFL Science Facebook post had more than 3600 shares.

### QUT creates Australia's first lithium-ion battery



In September 2017, news broke that QUT researchers had produced Australia's first lithium-ion battery after establishing the country's only facility capable of such manufacturing. IFE's Professor Peter Talbot said the research could be used to kickstart a commercial lithium-ion battery manufacturing industry in Australia, with the batteries being one of the most popular types of rechargeable batteries used in portable electronics from mobile phones to power tools and drones. This process could be automated to enable Australia to have a competitive advantage in a

manufacturing space that is currently dominated by China. The story was run by ABC Radio Brisbane, ABC Online, 4BC, 2GB, *Gizmodo Australia*, *Sustainability Matters*, *Industry Update*, *Manufacturers' Monthly*, *Process Online*, *Science Newsline* and Znet. The story was also widely watched via Facebook.



## Media highlights in 2017

Date	Topic	Researcher/s	Media outlet/s
Jan/Feb	Plateauing cropping productivity despite increased fertiliser use	Prof Peter Grace	<i>Farm Weekly, Queensland Country Life, regional media</i>
	Using drones and a hyperspectral camera to survey Western Australia's Ningaloo Reef	Assoc Prof Felipe Gonzalez, Dr Dmitry Bratanov	ABC News, Sky News, News Limited publications
Mar/Apr	Announcement of \$210M Food Agility CRC to help transform Australia's food system	Prof Bronwyn Harch	ABC, APN regional newspapers, <i>Food Processing, Get Farming, Grain Central</i>
	Prediction that coding would become a blue-collar job in the new digital economy	Prof Marek Kowalkiewicz	<i>Sydney Morning Herald, The Age, MSN and TVN</i>
	Research on drought tolerance in plants	Prof Sagadevan Mundree, Dr Brett Williams	Grain Central, <i>South Burnett Times</i>
May/Jun	Progress of a two-year trial of robotic hand pickers for capsicum crops	Prof Tristan Perez	ABC Rural Report
	Interactive digital elements of GOMA's new Marvel exhibition designed by QUT graduates	Dr Deb Polson	<i>Sydney Morning Herald, ABC TV News, ABC Weekend Breakfast, Brisbane Times, Fairfax Media publications</i>
	Discovery of a native Australian plant that can kill the Zika virus, in conjunction with industry partner HFFA	Dr Trudi Collet	7 News, AAP, <i>The Australian, The NZ Herald, News.com.au, Fairfax media, regional media, international media (UK, China and India)</i>
Jul/Aug	QUT research using drones to find, count and protect koalas	Dr Grant Hamilton	<i>The Courier-Mail, Sunshine Coast Daily, MyGC.com.au, Huffington Post, Unmanned Aerial Online</i>
	QUT Australian Centre for Robotic Vision's big win at the international Amazon Robotics Challenge in Japan with their robot, Cartman	Prof Peter Corke	<i>Sky News, Australian Financial Review, The Courier Mail, Sunday Canberra Times, 7 News, 2UE, APN, UK Star, GhanaWeb, RoboHub, CIO Australia, New Atlas, BBC News, Planet Genius</i>
Sept/Oct	QUT creates Australia's first lithium-ion battery	Prof Peter Talbot	ABC, 2GB, Gizmodo, <i>Sustainability Matters, Industry Update, Manufacturers' Monthly, Process Online, Science Newsline</i>
	Research developing single crystals that can bend	Assoc Prof John McMurtrie	Gizmodo, MSN, Breitbart USA, Global News Connect, Xinuonet, Newsline, Science Alert, <i>The Conversation, Australian Geographic</i>
	Scientists and farmers work together to wipe out African lovegrass	Assoc Prof Jennifer Firn	ABC Gippsland, The Environmental News Network, <i>Science Daily, Physics.org.</i>
Nov/Dec	Research using light to switch chemical reaction pathways	Prof Christopher Barner-Kowollik	<i>Nature Communications, AZoOptics, Nanowerk, Opli, phys.org.</i>
	Using blockchain to fight food fraud – tracking beef from paddock to plate	Prof Marcus Foth	<i>Brisbane Times, Fairfax Media, COSMOS, ABC Country Hour, Supermarket News NZ</i>

## Digital and social media

### IFE website ([www.qut.edu.au/ife](http://www.qut.edu.au/ife))

The IFE website, which is part of the QUT corporate website, contains detailed information about IFE's research programs, centres and facilities, as well as our events for the general public, staff and industry. The site attracted more than 12,000 visitors during 2017 (up 36 per cent from 8796 visitors in 2016).

### Twitter (@IFE\_QUT)

Twitter has been a significant engagement channel for IFE. We tweeted at least once a day throughout 2017, sharing news of research activities and achievements, upcoming events, new equipment and interesting articles and blogs relevant to IFE's research areas. By December 2017, IFE's Twitter account had almost 1500 followers (up from 1000 followers in December 2016).



### Instagram (@ife.qut)

In October 2017, IFE established a new Instagram account to further profile its research, events and achievements through images and video. By December 2017, the account already had more than 100 followers and is growing strongly.

### Flickr

In 2017, our Flickr collection grew to more than 1400 images of IFE staff, facilities and events. This year, we added to the growing library of images by profiling our researchers, facilities and several major events, such as AMAS, Sumitomo Electric launch, Senior Living Innovation preview, QUT Self-Driving Cars Forum, the lithium-ion battery project at Banyo, 2017 Science in Focus Image Competition finalists, War on Waste Forum and REF launch.

### QUTube

IFE has a playlist within QUT's YouTube channel, the QUTube, containing videos of IFE lectures and highlighting key research projects. This channel helps to increase the reach and impact of our work. In 2017, we added videos about designing smart cities and a Grand Challenge Lecture by Vice-Chancellor Professor Peter Coaldrake.

### Podcasts

This year, IFE introduced a new podcast channel via iTunes and added a podcast of the Grand Challenge Lecture by Vice-Chancellor Professor Peter Coaldrake and a Distinguished Visitor Lecture on autonomous robots by American roboticist Professor Ron Arkin from Georgia Tech.

# Awards and scholarships

## Awards and scholarships sponsored by IFE



### **Siganto Foundation Medal: Dr Jake Whitehead**

The Siganto Foundation Medal is awarded each year to an outstanding early-career QUT researcher for excellence in engineering research. It was established to support distinguished PhD graduates from the QUT Science and Engineering Faculty and foster career progression, knowledge dissemination and global recognition in the field of engineering. In addition to the Medal, the winner receives \$10,000 for transdisciplinary professional development and research activities both locally and internationally, funded jointly by IFE and The Siganto Foundation.

The 2017 Medal recipient was Dr Jake Whitehead, whose ultimate goal is to shape public policy to support the use of electric vehicles and transport systems powered using renewable energy sources which are shared rather than privately owned. Jake completed dual PhDs through QUT and the Royal Institute of Technology (KTH) in Sweden. Having completed his Bachelor, Masters and PhD qualifications in Engineering with QUT, Jake is currently employed as a post-doctoral research fellow at The University of Queensland's School of Civil Engineering. He is also the Director of Transmobility Consulting, through which he provides research expertise to both the public and private sectors, particularly in relation to energy-efficient vehicles, autonomous vehicles and shared mobility systems. His PhD thesis is titled: *"The expected and unexpected consequences of implementing energy-efficient vehicle incentives – an analysis of the varying and sometimes unintended effects of government incentives upon the demand, usage and pricing of energy-efficient vehicles."*

## Awards received by IFE researchers



### **Australian Computer Society Fellow: Professor Marcus Foth**

Professor Marcus Foth received a prestigious honour by being named a fellow of the Australian Computer Society (ACS). Professor Foth has been at the forefront of smart cities research and founded the Urban Informatics Research Lab at QUT in 2006. He was nominated for the award by the Smart Cities Council Australia and New Zealand.

### **QUT Distinguished Professor award: Professor Peter Corke**

QUT awarded the title of Distinguished Professor to Professor Peter Corke to recognise his outstanding international achievements in robotics. Professor Corke is recognised internationally and has had a considerable influence on people working at every level in his field - from undergraduate students who have benefitted from his interest in education and his abilities as an enthusiastic and innovative teacher, to international research leaders. Many know Peter personally because of the reach of his research and the teaching materials he has developed, including MOOCs, online resources and a library of video recordings. Professor Corke is remarkable in his field with an h-index of 60 and some 20,000 citations. He is a founding member of the highly successful Robotics Research Group at QUT and Director of the ARC Centre of Excellence for Robotic Vision, leading the centre's research.



### **2017 Fresh Science Queensland winner: Dr Annalena Wolff**

CARF researcher Dr Annalena Wolff was the winner of the 2017 Fresh Science Queensland competition, a national initiative that helps early-career researchers find and share their stories of discovery. The competition profiled her work with PhD student Chaturanga Bandara which used helium ion microscopy to unveil the mysterious anti-microbial properties of dragonfly wings and paves the way for future development of bacterial-resistant materials. Dr Wolff received a day of media training, and media exposure. Fresh Science Queensland is delivered in partnership with E-connect Communication and is supported by QUT, Griffith University, the University of the Sunshine Coast and the University of Queensland. During 2017, Dr Wolff also toured the world investigating the latest helium ion microscopy techniques, returning to QUT with international expertise to share with other researchers.

# Organisational structure

The IFE team catalyses, supports, conducts and profiles research and innovation aligned with IFE's research themes, enabling platforms and research infrastructure. An IFE organisational chart, current as of December 2017, is below.



# Participation in IFE

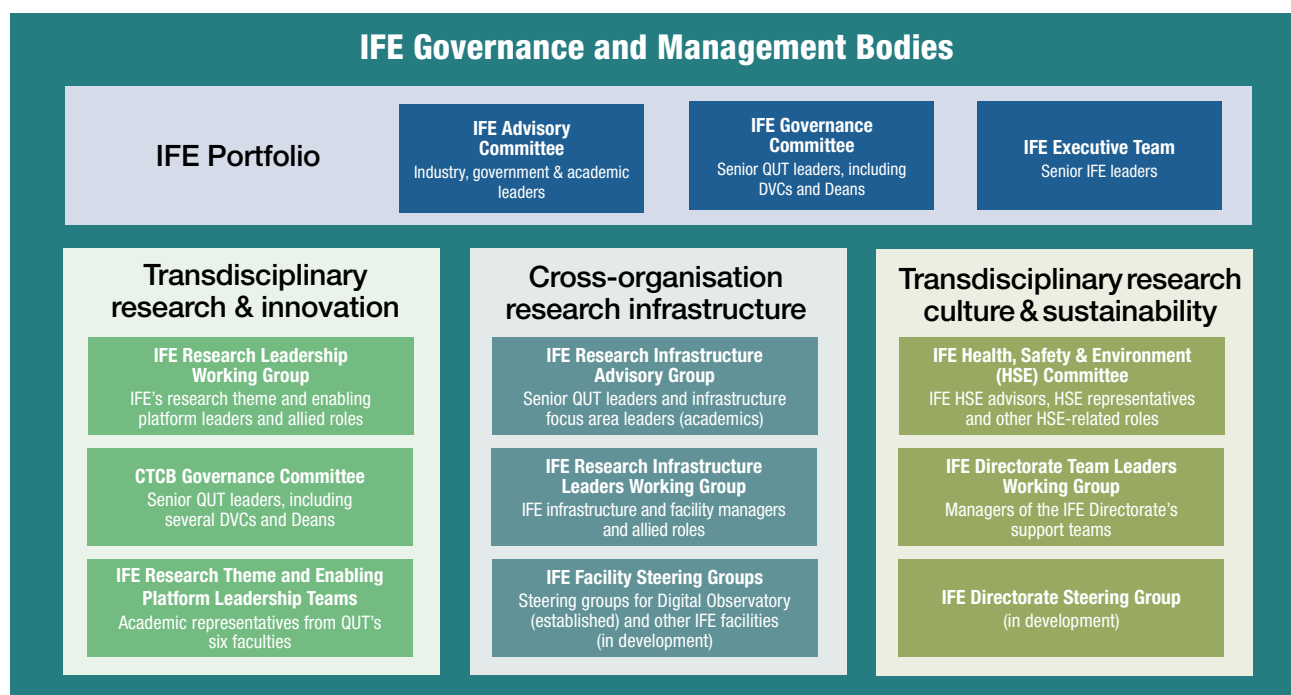
IFE helps QUT staff and higher degree research students conducting research aligned with the institute's mission to strengthen their research quality and impact by offering:

- university-wide transdisciplinary communities of practice
- connections to national and global research networks
- world-class research infrastructure and expertise
- funding for seed projects and industry and government co-investment projects
- assistance with developing research and innovation ideas and with links to industry, government and community research needs
- support with project delivery and finance, knowledge to innovation brokering, communications and profiling, and event management.

IFE has a diverse range of academic, research infrastructure specialist and professional staff, and also works with academics and higher degree research students from around QUT. The range of IFE staff and participants includes:

- Directorate staff specialising in strategy, governance, finance, research project delivery, communications, knowledge to innovation brokering, human resources and administration
- Research infrastructure specialist staff in IFE's facilities, including the Central Analytical Research Facility, Samford Ecological Research Facility, Banyo Pilot Plant Precinct, Mackay Renewable Biocommodities Pilot Plant, Visualisation and eResearch team, and the Research Engineering Facility
- Academic staff, including:
  - core IFE academic staff – research theme and enabling platform leaders, adjunct appointments, industry chairs and research fellows
  - collaborating academic staff from QUT's faculties who contribute their deep disciplinary expertise to specific IFE research activities
- Higher degree research students, including:
  - students supported by IFE scholarships
  - students supervised by academic staff aligned with IFE's research themes and enabling platforms
- Facility users, including staff and students from QUT's faculties who:
  - conduct research using IFE facilities
  - work in IFE's headquarters, the Science and Engineering Centre.

IFE has a range of committees and working groups that oversee the direction, performance, policies and safety of IFE.



## IFE Advisory Committee

The IFE Advisory Committee was formed this year to give IFE feedback on its strategic direction and progress. The industry, government and academic leaders on the committee advise IFE on its research priorities and infrastructure development, on partnership, profiling and fundraising opportunities, and on transdisciplinary research culture and practice.

The committee held its inaugural meeting on 2 November 2017 and will meet twice annually in future years. In 2017, the committee consisted of the following representatives from Australia, Europe and the US:

- Dr John Puttick – Committee Chair and QUT Council Member
- Dr Christine Williams – Acting Queensland Chief Scientist
- Dr Peter Isdale – Managing Director, Intergyre
- Mr Gavin Smith – President and Chairman, Robert Bosch Australia
- Dr Lutz Heuser – CEO, The Urban Institute
- Professor Molly Jahn – University of Wisconsin-Madison
- Professor Frank Caruso – The University of Melbourne
- Professor Arun Sharma – Deputy Vice-Chancellor (Research and Commercialisation), QUT *ex officio*
- Professor Bronwyn Harch – Executive Director, IFE *ex officio*.



## IFE Governance Committee

IFE's Governance Committee comprises senior leaders from around QUT. They oversee the direction, performance, policies and safety of IFE. In 2017, the committee consisted of:

- Professor Arun Sharma – Deputy Vice-Chancellor (Research and Commercialisation) as Chair
- Professor Carol Dickenson – Senior Deputy Vice-Chancellor
- Professor Scott Shepherd – Deputy Vice-Chancellor (International and Development)
- Professor Bronwyn Harch – Executive Director, IFE
- Professor Gordon Wyeth – Executive Dean, Science and Engineering Faculty
- Professor Robina Xavier – Executive Dean, QUT Business School
- Mr Graham Fryer – Executive Director, Finance and Resource Planning
- Ms Melissa Burton – Institute Manager, IFE
- Mr Sach Jayasinghe – Director, Research Infrastructure, IFE.

## IFE Executive Team

Day-to-day management of the operations of IFE is the responsibility of the IFE Executive Team, which in 2017 included:

- Professor Bronwyn Harch – Executive Director as Chair
- Professor Sagadevan Mundree – Director, Centre for Tropical Crops and Biocommodities
- Mr Sach Jayasinghe – Director, Research Infrastructure
- Ms Melissa Burton – Institute Manager
- Dr Mark Gibbs – Director, Knowledge to Innovation
- Mr Tim Campbell – Executive Officer.

---

## Health, safety and environment

The IFE Health, Safety and Environment (HSE) Committee provides a consultative forum for addressing broad HSE matters. Membership includes IFE management, Science and Engineering Faculty representatives, HSE professionals, IFE HSE Advisors and IFE staff, including elected Health and Safety Representatives. During 2017, the HSE Committee met quarterly to address and resolve HSE issues, consider HSE reports, monitor workplace hazards and protective measures, recommend training and develop HSE policies, procedures and programs.

An important role for the HSE Committee is the review of safety concerns, workplace injuries, hazards and near misses. In 2017, eight workplace injuries or illnesses, 20 safety issues and two environmental issues were reported. There was also one WorkCover claim lodged. The top five reasons for incidents included falls, trips and slips, being hit by moving objects, body stressing, sharps and vehicle incidents (work journeys). Environmental incidents related to inappropriate disposal of waste and noise in the workplace. As a result of investigations into these

incidents, IFE has developed appropriate controls and procedures to mitigate against potential risks associated with these hazards. Following a risk assessment in IFE facilities identified as hazardous area zones, the hazard of reticulated hydrogen in the Central Analytical Research Facility (CARF) laboratories was eliminated by acquiring a point-of-use hydrogen generator.

During 2017, the QUT Department of HSE (DHSE) reviewed how HSE services are provided at the university, resulting in a restructure of the DHSE workforce profile and centralisation of HSE functions. A key outcome was the creation of a Senior HSE Coordinator role embedded within IFE yet reporting to the DHSE.

Other highlights for 2017 included successful completion of laboratory inspections using online surveys and the management of corrective actions using a new SharePoint site. An increased number of Wellness Ambassadors supported the IFE Directorate, CTCB and Distributed Sites, providing an excellent program of activities throughout 2017.

# Research ethics and integrity

## Animal ethics

The QUT University Animal Ethics Committee (UAEC) is responsible for monitoring the care and use of animals (including housing conditions, practices and procedures involved in the care of animals in facilities) on a regular and ongoing basis to assess compliance with the Australian Code for the Care and Use of Animals for Scientific Purposes, the NHMRC Guidelines for promoting the wellbeing of animals used for scientific purposes (2008), and decisions of the UAEC.

On 8 February 2017, the UAEC review panel visited IFE's Samford Ecological Research Facility to assess the facility, traps and equipment and records of activities involving animals. The panel agreed that most of the animal work underway at the facility falls outside scope (the majority of the projects relate to insects only), and as such does not require review, approval and monitoring by the committee.

## Human ethics

All human research conducted in Australia is governed by legislation that establishes the rights for participants and obligate the researcher and institution with specific responsibilities. These responsibilities are articulated in the ethical principles of research merit, integrity, justice, beneficence and respect. For research projects involving human subjects, IFE researchers use the ethics approval processes of QUT's faculties and the central Office of Research Ethics and Integrity.

## Biosafety

The IFE has a number of biosafety obligations due to conducting research activities involving genetically modified (GM) and high-risk, non-genetically-modified biological material. These activities are approved and monitored by the QUT Biosafety Committee to ensure compliance with relevant legislation and regulations.

The IFE and the Centre for Tropical Crops and Biocommodities (CTCB) has approval from the Australian Office of the Gene Technology Regulator to carry out research with GM biological material at designated field sites, CTCB laboratories and the Genomics laboratory of IFE's Central Analytical Research Facility. The CTCB laboratories and the CARF Genomics laboratory are also approved quarantine facilities under an agreement with the Australian Department of Agriculture and Water Resources.

IFE also has approval from the University Biosafety Committee to carry out large-volume fermentation work using high-risk biologicals at our Mackay Renewable Biocommodities Pilot Plant.



# Financial report

The table below provides a summary of transactions on IFE-related accounts for the period 2015–2017. This summary does not include any co-funded or fully funded initiatives by IFE that are attributed to other university accounts (eg. a division, faculty or school account). Revenue tracks research income administered by IFE. Research attributed to other university units supported by IFE (eg. through support services, research infrastructure provision or collaboration) is not included in the revenue description.

Revenue	2015 \$ '000s	2016 \$ '000s	2017 \$ '000s
<b>Research</b>			
Competitive Grants+	7438	6309	9658
University Distributions	1843	1901	3765
Commercial	7664	5690	7548
Sub-total	16945	13900	20970
<b>Operations</b>			
University Distributions	15446	14004	14768
Other	1631	658	658
Sub-total	17077	14662	15426
<b>TOTAL REVENUE</b>	<b>34021</b>	<b>28562</b>	<b>36396</b>
<b>Expenses</b>			
	\$'000s	\$'000s	\$'000s
<b>Research</b>			
Employee Costs	8472	8130	9342
Non-Employee Costs	6824	5384	5062
Sub-total	15296	13514	14403
<b>Operations</b>			
Employee Costs	13684	14678	15028
Non-Employee Costs	5208	5537	4415
Sub-total	18892	20215	19443
<b>TOTAL EXPENDITURE</b>	<b>34188</b>	<b>33729</b>	<b>33847</b>
Opening Retained Funds	12831	13408	8497
Profit/(Loss)	(166)	(5167)	2549
Retained Funds Transfer	146	(730)	(4)
Capital Acquisitions++	1053	494	1202
Depreciation	1650	1480	1420
<b>Closing Retained Funds</b>	<b>13408</b>	<b>8497</b>	<b>11260</b>

+ Grants to Chief Investigators in Faculties (e.g. ARC Discovery and Linkage projects) are not included.

++ Does not include Major Equipment (SMEP).







Brisbane Australia

## Contact us

### Location

Level 6, P Block  
QUT Gardens Point campus  
2 George Street  
Brisbane QLD 4000

### Enquiries

Email [ife@qut.edu.au](mailto:ife@qut.edu.au)  
Web [www.qut.edu.au/ife](http://www.qut.edu.au/ife)  
Phone +61 7 3138 9500  
Mail GPO Box 2434, Brisbane QLD 4001  
Fax +61 7 3138 4438  
 [IFE\\_QUT](#)  
 [ife.qut](#)

QUT acknowledges the financial support of the Australian and Queensland Governments and Atlantic Philanthropies in the establishment of the Institute for Future Environments and the Science and Engineering Centre.