QUT ife
Institute for Future Environments

REAL WORLD RESEARCH
Annual Report 2018

AUGMENTED REALITY

Unlocking the experience is easy:

Step 1:
Download the free IFEXperience app on the Apple or Google Play store. Search for the free IFEXperience app on the Apple or Google Play store, and download to your smartphone or tablet.

Step 2:
Open the IFEXperience app and allow camera access. NB: The app cannot work without access to your smartphone's camera. If permission is rejected or missed, you will need to grant access in your phone's system preferences before you can use the app.

Step 3:
Hold your mobile device over the cover image while the app is active and watch the cover image come to life.

Want more?
There are additional augmented reality experiences embedded in images on page 48 and page 55. Just look for the augmented reality symbol.

Questions?
Contact **ife@qut.edu.au**

What is augmented reality?
Augmented reality is an interactive experience adding layers of digital information such as videos, graphics and sound to our view of the real world.

About the cover image
Our augmented reality cover was created using time-lapse photography and microscopy to show how coral tissues adapt to climate-related stress. QUT researchers Dr Luke Nothdurft and Brett Lewis are studying the impact of large amounts of sediment falling on coral colonies after tropical storms to better understand how coral responds to fragmentation and rebuilds. This provides vital clues to unlocking improvements to the most efficient reef restoration methods, which currently involves fragmenting adult corals, growing these fragments in coral nurseries and re-attaching the new adult colonies to degraded reefs.

Brett and Luke's work has created some incredible visual media that has been viewed more than 10 million times online, has featured in dozens of documentaries for agencies such as the BBC, ABC and PBS, and has been covered by hundreds of news media outlets. The amazing visual research is also being used in museums and educational institutions in more than 15 countries – with the aim of inspiring and bringing the public closer to the issues facing coral reefs around the world.

The IFEXperience app was developed by IFE's Visualisation and eResearch (ViseR) team. For more information, visit **www.viser.net.au**

ABOUT US

Our research is focused on progress, pushing the boundaries and developing new ideas through transdisciplinary thinking.

The Institute for Future Environments (IFE) is a transdisciplinary research and innovation institute at Queensland University of Technology (QUT) in Brisbane, Australia. 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 competiveness.

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2018 HIGHLIGHTS ☑

Transdisciplinary research and innovation

☑ **250+**
current research and
consultancy projects

☑ **$441,720**
Catapult funding awarded to launch
QUT transdisciplinary research

Research highlights

☑ **Sugarcane waste by-products**
feeding the future of animal production

☑ **Tobacco plants** as lifesavers

☑ **Creating future farms** with
nitrogen sensors

☑ **Innovation to combat
cyberbullying** by 2025

☑ **Citizen scientists unite** to help
the Great Barrier Reef

☑ **Australian Cancer Atlas** unpacks
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☑ **Building on assets** with a plug 'n' play
hydrogen production pilot plant

☑ **Designing** out plastic waste

☑ **Investigating innovation** in Australian
biofuels and biorefining

☑ **Unleashing** the suburban economy

☑ **Examining climate change** and the
role of women in agriculture

Cross-organisation research infrastructure

☑ **7** research facilities

☑ **Launch** of Digital Observatory

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

☑ **$1.46 million**
in new assets

Transdisciplinary research culture and sustainability

☑ **$43 million** annual revenue

☑ **214 staff**, full-time equivalent

☑ **400+** researchers on IFE-aligned projects

☑ **4500+** attendees at IFE events

☑ **Local, national and global** media
coverage on IFE researchers and projects (p57)

☑ **Award-winning** researchers (p60)

MESSAGE FROM THE EXECUTIVE DIRECTOR

I had the privilege of acting as Executive Director of IFE from May 2018 to January 2019. My predecessor, Professor Bronwyn Harch, had established a strong strategic direction and organisational culture for the institute, and my goal was to maintain IFE's momentum and continue the implementation of its 2017–2020 Strategic Actions. I would like to thank Bronwyn – on behalf of everyone at QUT – for her outstanding leadership as IFE Executive Director and formerly as Deputy Director (Research) of IFE and Assistant Dean (Research) of the Science and Engineering Faculty.

IFE's research and innovation portfolio had many successes in 2018. The institute secured funding for several major new projects, including the H2Xport hydrogen production project (p40), the National Tree Genomics Program (p12), and two Smart Farming Partnerships through the Australian Government's National Landcare Program (p17). All these projects are collaborations with many academic and industry partners and demonstrate IFE's commitment to research that makes an impact in the real world by protecting and enriching our natural, built and digital environments. They will provide a wide range of economic, social and environmental benefits to Queensland and Australia.

After identifying three or four primary domains of research within each of IFE's research themes and enabling platforms, we appointed 23 Domain Leaders – many of them early- and mid-career researchers. The group includes academics from all six of QUT's faculties, so as well as developing new research projects and partnerships they will help to consolidate IFE's and QUT's culture of transdisciplinary collaboration and communication.

IFE's research infrastructure portfolio also took great strides forward. The Visualisation and eResearch (ViseR) team developed the digital platforms for three major projects released in 2018 (p46): Virtual Reef Diver, the Australian Cancer Atlas and Ground Truth. The Central Analytical Research Facility (CARF) extended its partnership with Rio Tinto and supported QUT research and commercial activity in a wide range of ways, including co-authoring journal papers, training HDR students in analytical technologies and techniques, and supporting bids for major new research equipment, including a successful ARC Linkage Infrastructure, Equipment and Facilities (LIEF) grant of $2.7 million for an Atomic Scale Transmission Electronic Microscope (p45).

I would like to thank all of IFE's staff, researchers and partners for the support they gave me during my time as Acting Executive Director and for continuing to make the institute an exciting place to work and a wellspring of ideas and innovation. Their dedication and hard work are behind all the achievements cited and the many other activities and accomplishments you can read about in this report.

On 29 January 2019, I passed the reins to IFE's incoming Executive Director, Professor Kerrie Wilson. Kerrie has a first-class record as an environmental science researcher and an institutional leader. Most recently, Kerrie has been Director of the ARC Centre of Excellence for Environmental Decisions and Deputy Associate Dean of Research in the Faculty of Science at The University of Queensland. Kerrie has received numerous national awards, including the 2017 Australian Academy of Sciences Nancy Millis Award and the 2016 Prime Minister's Frank Fenner Life Scientist Prize. I am looking forward to working with Kerrie and watching the institute continue to grow under her leadership.

Professor Ian O'Hara
Acting IFE Executive Director (May 2018 – January 2019)

"I was thrilled and honoured to be selected as the new Executive Director of the Institute for Future Environments. IFE is doing important work across a wide range of connected fields to address urgent problems and opportunities relating to our natural, built and digital environments. I look forward to working closely with the institute's staff and researchers, and with its many partners and stakeholders, to continue carrying out the IFE mission of generating technologies and ideas that make our world more sustainable, secure and resilient."

Professor Kerrie Wilson
IFE Executive Director (from 29 January 2019)

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).

Right challenge
- Driven by the needs and required timeframes of industry, government and communities
- Linking environmental scanning to impact planning to realise partnership and project investment opportunities
- Harnessing cross-faculty disciplines and thought leadership

Clear roles for collaboration
- Integrated and aligned Institute planning (Blueprint 5, IFE and operational units within IFE) driving transparency and accountability
- Co-developed with internal and external stakeholders
- Clarity of roles and functions empowering participation in IFE

Motivated by impact
- Performance managed by regular reporting of progress on impacts and outcomes
- Building a research and professional services culture focused on impact and continual improvement and underpinned by both systems and capability

Right scale
- Growing the scale of partnerships and investment in research and innovation
- Aligned to and contributing to QUT Strengths
- Aligned to objectives for impact

Empowering users
- Providing systems and environment to support self-directed learning
- Achieving balance of supervised and self-directed end-users
- Providing continuing professional education for end-users

Client focused
- Service quality underpinned by research excellence
- Client-centric interactions and processes
- Long term sustainability of core research infrastructure and capabilities

Delight-filled partnerships
- Client-centric interactions for outcome delivery
- Trusted advisor and partner
- Deepened understanding of shared goals and differences (internal & external)

Amplifying our investment
- Continually acquiring cutting-edge technology and new research capabilities through increased infrastructure competitive grant income
- Aligning research results from new or more efficient leveraging of research infrastructure capabilities
- Facility use contributing to higher research quality

Nurturing agile and resilient teams
- More networked/connected and self-aware teams
- Increased emphasis on agility and execution of strategy

Transdisciplinary research and innovation

Cross-organisation research infrastructure

Transdisciplinary research culture and sustainability

Enabling Platforms

Facilities

Research support professionals

Themes

Distributed sites
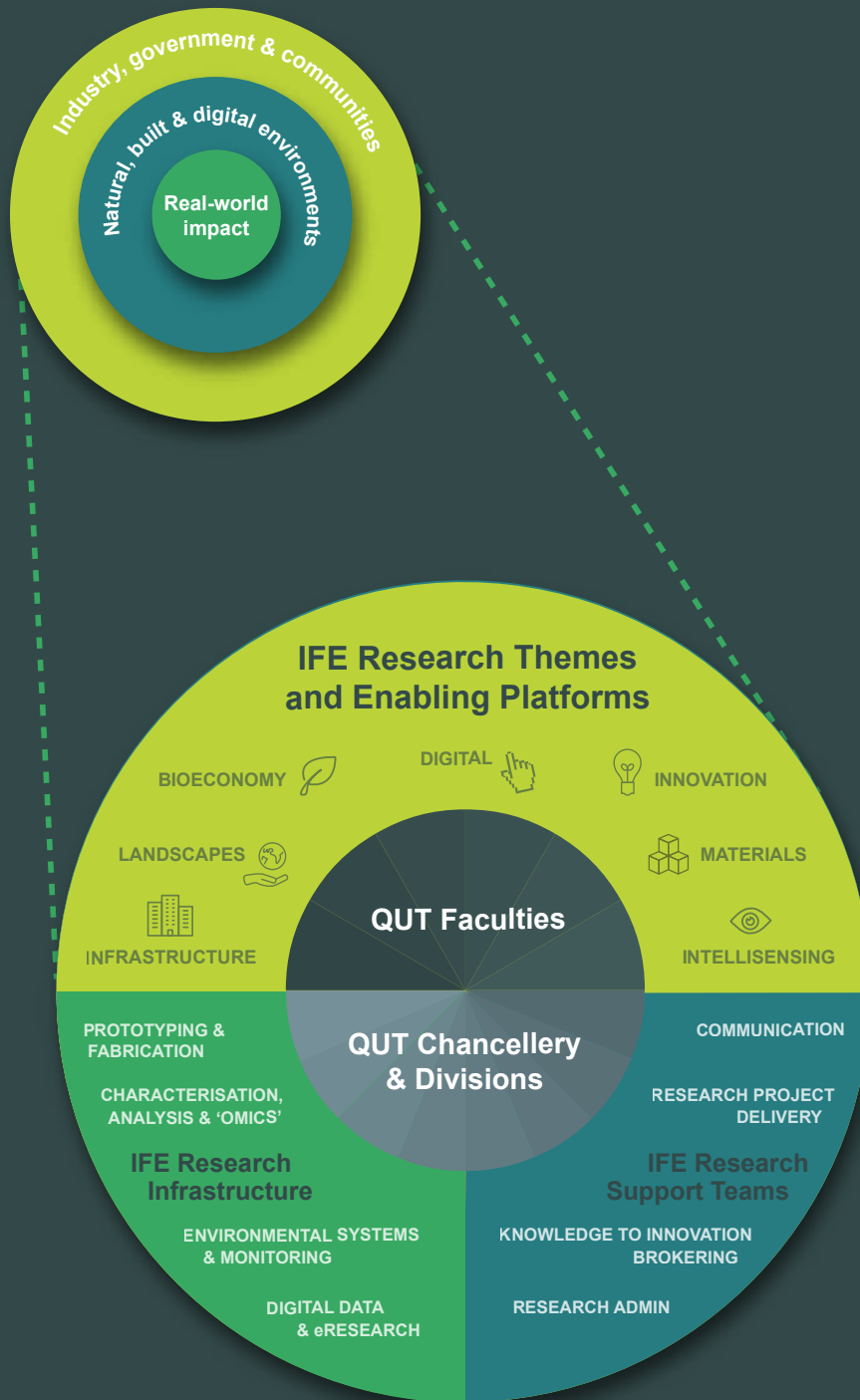
IFE participants (academics)

CTC8

2017–2020 Strategic Actions

CATALYSING INNOVATION

IFE partners with industry, government and non-profit organisations 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

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.

We conduct high-impact research that is:

- **responsive** – considering local and global human and economic needs
- **collaborative** – working closely with partners in government, industry and the community
- **transdisciplinary** – bringing many fields across QUT together
- **technology-focused** – leveraging advanced technological capabilities.

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, and the Australian Centre for Robotic Vision. 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.

Prioritising our research: centres, themes, enabling platforms and domains

IFE prioritises its research focus using centres specialising in industry and technological growth areas, themes linked to specific social challenges and economic sectors, and enabling platforms which are technologies, techniques and systems that can solve a wide range of problems for industry and society.

Centres concentrate expertise and capability and, in collaboration with partners, foster research and develop new technologies that provide solutions and contribute to industry growth.

Research Centre	Key research areas
Centre for Tropical Crops and Biocommodities	• Plant biotechnology • Plant genomics • Biorefining and bioproducts

Australian Centre for Robotic Vision	• Sensing – Robust Vision • Understanding – Semantic Representations • Acting – Vision and Action • Learning – Visual Learning • Technology – Algorithms and Architecture

Our research agenda

Our research themes and enabling platforms are closely aligned with federal and state government science and research priorities. In 2018, IFE introduced domains within each theme and platform to expand its transdisciplinary research and innovation leadership and achieve greater impact in the real world.
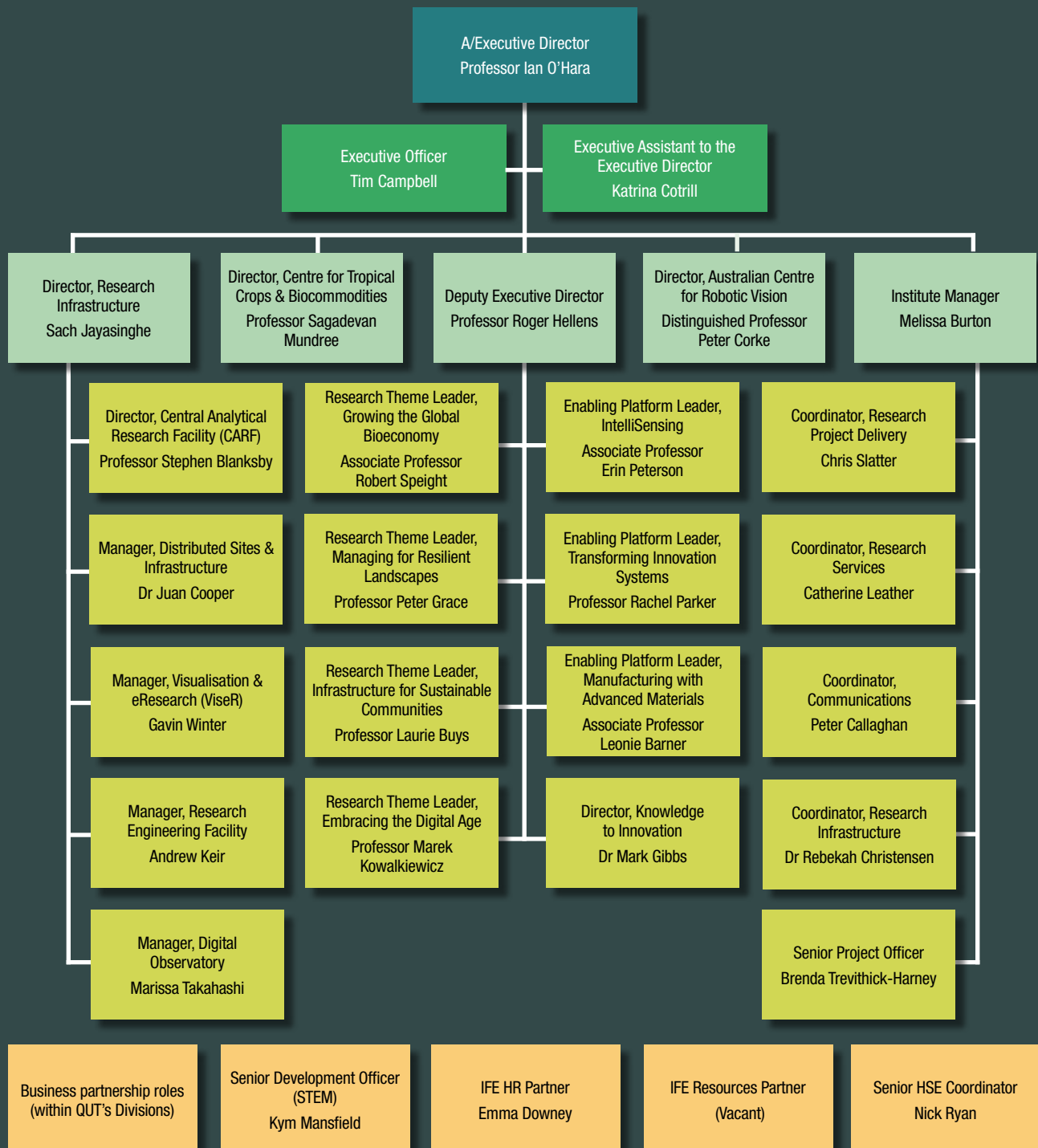
Each research theme and enabling platform has an academic leader, a leadership team with broad relevant disciplinary expertise, dedicated research support staff, a network of transdisciplinary research academics and access to IFE facilities.

Theme/Enabling Platform	Domains
Growing the Global Bioeconomy	• Crops • Animal production • Food and nutrition • Industrial biotechnology

Theme/Enabling Platform	Domains
Managing for Resilient Landscapes	• Sustainable agro-ecosystems • Ecological applications • Optimising natural resources

Theme/Enabling Platform	Domains
Infrastructure for Sustainable Communities	• Future living • Mobility • Energy and water management • Senior living

Theme/Enabling Platform	Domains
Embracing the Digital Age	• Living, working, thinking and learning in the digital age

Theme/Enabling Platform	Domains
IntelliSensing	• Data generation • Intelligence from sensing • Decision making

Theme/Enabling Platform	Domains
Transforming Innovation Systems	• Technology ecosystem • Innovation culture • Social licence

Theme/Enabling Platform	Domains
Manufacturing with Advanced Materials	• Devices, plant and installations • Metals, rocks and inorganic material • Organic and soft matter • Modelling and digital manufacturing

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 2018, is below.

A/Executive Director
Professor Ian O'Hara

Executive Officer
Tim Campbell

Executive Assistant to the Executive Director
Katrina Cotrill

Director, Research Infrastructure
Sach Jayasinghe

Director, Centre for Tropical Crops & Biocommodities
Professor Sagadevan Mundree

Deputy Executive Director
Professor Roger Hellens

Director, Australian Centre for Robotic Vision
Distinguished Professor Peter Corke

Institute Manager
Melissa Burton

Director, Central Analytical Research Facility (CARF)
Professor Stephen Blanksby

Research Theme Leader, Growing the Global Bioeconomy
Associate Professor Robert Speight

Enabling Platform Leader, IntelliSensing
Associate Professor Erin Peterson

Coordinator, Research Project Delivery
Chris Slatter

Manager, Distributed Sites & Infrastructure
Dr Juan Cooper

Research Theme Leader, Managing for Resilient Landscapes
Professor Peter Grace

Enabling Platform Leader, Transforming Innovation Systems
Professor Rachel Parker

Coordinator, Research Services
Catherine Leather

Manager, Visualisation & eResearch (ViseR)
Gavin Winter

Research Theme Leader, Infrastructure for Sustainable Communities
Professor Laurie Buys

Enabling Platform Leader, Manufacturing with Advanced Materials
Associate Professor Leonie Barner

Coordinator, Communications
Peter Callaghan

Manager, Research Engineering Facility
Andrew Keir

Research Theme Leader, Embracing the Digital Age
Professor Marek Kowalkiewicz

Director, Knowledge to Innovation
Dr Mark Gibbs

Coordinator, Research Infrastructure
Dr Rebekah Christensen

Manager, Digital Observatory
Marissa Takahashi

Senior Project Officer
Brenda Trevithick-Harney

Business partnership roles (within QUT's Divisions)

Senior Development Officer (STEM)
Kym Mansfield

IFE HR Partner
Emma Downey

IFE Resources Partner
(Vacant)

Senior HSE Coordinator
Nick Ryan

Centre for Tropical Crops and Biocommodities

The Centre for Tropical Crops and Biocommodities (CTCB) brings together an outstanding mix of international expertise in plant biotechnology, process engineering, industrial chemistry and commercialisation, creating a continuum of research and development from laboratory through to finished product. Our researchers have specialist expertise in tropical agriculture and the high-value biocommodities sector, and support agricultural advancement in developing countries. We have crop specialisations in bananas, sugarcane and tropical pulses. Our key research areas are:

- plant biotechnology to help crop producers grow more food using less resources
- plant genomics to improve the genetic quality of a plant, producing stronger, more nutritious and more resilient crops
- biorefining and bioproducts to convert agricultural waste into valuable and reusable materials including green chemicals, biofuels and other bioproducts.

The CTCB's strategic focus continues to be targeted strongly towards applied outcomes from research and development of tropical and sub-tropical crops. Our current outcomes include patents, advice to industry through consultations, products, processes, industry training, undergraduate and postgraduate education. The CTCB has a broad diversity of projects in Australia and internationally, supporting local and global communities and industries. Currently the centre has active collaborations/activities in Africa (Uganda, Kenya, Ethiopia, Malawi, South Africa, Mauritius), Asia (India, China, Thailand, Japan, Indonesia, Cambodia, Philippines, Vietnam), North America (USA, Canada, Costa Rica, Mexico), South America (Brazil, Peru, Nicaragua), Middle East (Iran) and Europe (Austria, Germany, Netherlands, Spain, United Kingdom).

Professor Sagadevan Mundree, Centre for Tropical Crops and Biocommodities Director

Australian Centre for Robotic Vision

At the Australian Centre for Robotic Vision, headquartered at QUT, our aim is to enable a new generation of robots that see, understand and adapt to complex, unstructured and dynamically changing environments just as humans do. Funded for $25.6 million over seven years (to 2020), the Centre brings together more than 200 researchers from across Australia and the world. Ours is the largest university-based robotic vision lab, spanning QUT, University of Adelaide, Australian National University and Monash University. The Centre's interdisciplinary team also includes CSIRO's Data61 and overseas universities and research organisations. Our formation recognises that the breakthrough science and technologies needed to create a new generation of 'truly useful' robots can only be achieved through concerted, large-scale and collaborative effort.

In June 2018, the Centre released Australia's first Robotics Roadmap as a 'living guide' to how Australia can harness the benefits of a new robot economy. Robots are vital to our future prosperity with predictions that Australia's national productivity stands to gain $2.2 trillion by 2033 through increased use of robotics and automation, while Queensland could earn 1.1 million new jobs equating to a $117.5 billion boost to Gross State Product. Other key achievements during 2018 included:

- bringing the International Conference on Robotics and Automation to Brisbane and Australia for the first time
- witnessing robotic vision as the superpower behind RangerBot, the world's first marine robot put to work in a coral seeding project on the Great Barrier Reef
- supporting an Australia-first trial of SoftBank's popular social robot, Pepper, in hospitals
- launching a world-first robotic vision competition to address the problem of overly-confident robots misidentifying objects in the real world.

Distinguished Professor Peter Corke, Centre Director, Australian Centre for Robotic Vision

Research theme: Growing the Global Bioeconomy

Leadership	
THEME LEADER	• Associate Professor Robert Speight
DOMAIN LEADERS	• Dr Fatima Naim Eftkehari – Crops • Dr Mark Harrison – Animal Production • Associate Professor Jolieke van der Pols – Food and Nutrition • Dr Jan Zhang – Industrial Biotechnology and Bioprocessing • Dr Alice Payne – Waste
LEADERSHIP TEAM	• Science and Engineering/CTCB: Dr Peter Prentis; Dr Melody de Laat; Dr Kevin Dudley; Dr Matthew Phillips; Dr Fatima Naim Eftkehari; Dr Mark Harrison; Dr Jan Zhang • Health: Associate Professor Jolieke van der Pols • QUT Business School: Dr Judy Matthews • Creative Industries: Dr Alice Payne • qutbluebox: Callum Hickey • Knowledge to Innovation Broker: Camilla Roberts
HOSTED QUT RESEARCH CENTRE	• Centre for Tropical Crops and Biocommodities

Real-world context	
KEY TRENDS	One in eight people around the world does not have enough food to eat, and one in four has 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.
GRAND CHALLENGES	• Meeting human needs for food, feed, fibre and fuel as the global population grows. • Transforming the bioeconomy to make it more productive, profitable and sustainable. • Raising public awareness of the safety and benefits of genetically modified agricultural products.

Our research strategy	
FOCUSES	We are investigating how to: • develop crops with improved nutritional value, taste and convenience • reduce reliance on water, nutrients and sprays • add value to commodity crops • turn surplus biomass into sustainable fuels, chemicals and other valuable products.
IMPACTS	Our research is designed to drive the following changes in the real world: • more profitable bioeconomy industries • more sustainable bioeconomy inputs • increased health benefits from food.

Research and impact highlights

During 2018, the Growing the Global Bioeconomy theme and the Centre for Tropical Crops and Biocommodities (CTCB) have made significant impacts towards securing our food, agriculture and industrial systems as we face new future challenges.

Four domain leaders were appointed to champion activities in bioeconomy production systems, processing and use. These domains are driving new research and transdisciplinary collaborations, and have brought together a diverse range of QUT researchers with industry partners.

Significant work on waste use and helping make bioeconomy industries profitable has been achieved through a Biorefineries for Profit Rural R&D for Profit project that is close to completion. This project has delivered new animal feeds and feed supplements, developed a process to produce valuable pharmaceutical intermediates from cotton waste, made advanced fuels, and explored innovation and impact challenges in the sugar industry from a business perspective.

A second Rural R&D for Profit project focused on livestock industry waste and involving 19 partners started in 2018. The project comprises 14 smaller projects addressing aspects of livestock industry waste and conversion technologies.

Another major value-adding project is developing advanced anaerobic digestion technologies to convert sugarcane harvest residues into biogas for upgrading to sugarcane industry transport fuels. This project has installed a significant pilot scale system at QUT's Mackay Renewable Biocommodities Pilot Plant where the new technologies are being tested.

The Mackay Pilot Plant ramped up operations in 2018, including renovation work to enable future fermentation scale-up using engineered microorganisms to the required containment levels. This facility complements the new fermentation laboratory at QUT's Gardens Point campus that consolidates existing equipment and brings in state-of-the-art processing and analytical instrumentation.

On the world stage, we led another delegation to the annual World Congress on Industrial Biotechnology in Philadelphia, USA along with representatives from the Queensland Government, including Minister for State Development, Manufacturing, Infrastructure and Planning, Hon. Cameron Dick and QUT Adjunct Professor Chris Tindal (ex-US Navy). The delegation also visited Pacific Northwest National Laboratory, The Pentagon and several companies to help build partnerships and attract investment to Queensland.

QUT hosted a 'Plant and their Microbiomes in Extreme Environments' event featuring leading international delegates exploring opportunities for using plant-microbe interactions to increase crop resilience. Associate Professor Caroline Hauxwell chaired the prestigious 2018 International Congress of Invertebrate Pathology and Microbial Control and the 51st Annual Meeting of the Society for Invertebrate Pathology on the Gold Coast. The conference welcomed researchers from around the world as well as leading global companies.

QUT's overall leadership in bioenergy research was recognised with an award from Bioenergy Australia for achieving impact through industry-focused research (see p60).

QUT researchers prepared a report titled *Biofuels to Bioproducts: A Growth Industry for Australia* which proposes a five-point plan to grow Australia's biofuels and bioproducts industry. Endorsed by Bioenergy Australia, the report was launched at Parliament House in Canberra on 28 March.

Our bioeconomy research was enhanced by the appointment of four new Advance Queensland Research Fellowships to: Dr Carlos Luna-Flores to manufacture sustainable astaxanthin for animal and aquaculture feeds; Dr Upendra Shekhawat for the development of disease-resistant bananas; Dr Jan Zhang to convert biosolids to biofertiliser; and Dr Darryn Rackemann to further develop a leading biorefining technology to commercialisation. The three 2017 fellowship recipients are progressing research to develop more resilient, nutritious chickpea and pigeonpea varieties.

The National Tree Genomics Program, a five-year, $11.3 million investment by Hort Innovation, will be led by QUT and the University of Queensland (QAAFI). The project will develop genomic, genetic and phenotypic toolboxes to improve the productivity of five tree crops. QUT will lead the genotype prediction toolbox ($3.8 million over five years) with partners including Western Sydney University, UQ (Science) and JAIN Irrigation (India).

In collaboration with Meat and Livestock Australia, QUT research led by Associate Professor Carrie Hauxwell identified the role of mealybug insects in the pasture dieback in Queensland and released technical information to help landholders identify and mitigate mealybug infestations.

Associate Professor Robert Speight, Growing the Global Bioeconomy Theme Leader

Case study: Sugarcane by-products feeding the future of animal production

Project or program title	Biorefineries for Profit
QUT project team	CTCB: Associate Professor Robert Speight, Dr Mark Harrison
Partner organisations	Australian Government Department of Agriculture and Water Resources, Advance Queensland, Sugar Research Australia, Bioproton Pty Ltd, Ridley Agriproducts, Kennedy Creek Lime, The University of Queensland, Cotton Research and Development Corporation, Forest & Wood Products Australia, Australian Pork Ltd, Southern Oil Refining, NSW Department of Primary Industries.
Timeline	February 2016 – February 2019

Why it matters

Global demand for Australian animal products such as meat, cheese and milk powder is increasing, and our agricultural sector is responding to this demand by increasing animal production. This means we also need to produce more animal feed. In order to supply growing export markets, Australian farmers are actively looking for feed ingredients that are cheaper, more widely available and with nutritional values as good as, if not better than, existing ingredients.

How the IFE is making an impact

Up to 35 million tonnes of sugarcane is grown annually in Australia, producing a range of crop by-products including 10 million tonnes of bagasse (a fibrous residue left over when the sugarcane is processed) and trash (the tops and leaves of the sugarcane plant that remain in the field when the stalk is harvested).

QUT researchers are looking for ways to upcycle these sugarcane industry by-products into animal feed ingredients and additives allowing what would traditionally be low-value products to contribute significantly to farm income. Currently, sugarcane bagasse and trash are not very digestible nor nutritious in their native state. By developing new bagasse and trash treatment processes, and probiotic and enzyme supplements, QUT's scientists are changing the structure and chemistry of bagasse and trash to improve their nutritional value and transform them into quality feed ingredients for animals such as cattle, chickens and pigs.

The benefits to Australian agriculture are significant, with these new future-proofing technologies primed to create flow-on effects in the form of more plentiful and cheaper feed ingredients for animal producers, new income streams for crop producers and processors, and increased employment and economic development opportunities for regional areas. There is also potential to bring high-tech manufacturing to sugarcane-growing regions by using biotechnology and fermentation to transform bagasse and trash into other products including fuels, fine chemicals and materials.

This project is supported by Sugar Research Australia, through funding from the Australian Government Department of Agriculture and Water Resources as part of its Rural R&D for Profit program, the Queensland Government and project partners including Cotton Research and Development Corporation, Forest & Wood Products Australia, Australian Pork Ltd, Southern Oil Refining, NSW Department of Primary Industries and QUT. Advance Queensland Innovation Partnerships funding also supported this research, with additional project partners including Bioproton Pty Ltd, Ridley Agriproducts, Kennedy Creek Lime and The University of Queensland.

Research infrastructure for the real world

Scale-up of the research into transforming sugarcane by-products into feed ingredients takes place at QUT's Mackay Renewable Biocommodities Pilot Plant, based on the site of an operating sugar mill. The pilot plant is a unique research and development facility that can convert biomass into biofuels, green chemicals and other bioproducts. The manufacture of new probiotics developed to work with the bagasse feed has been scaled up and initial livestock feeding trials have been performed to explore their effects in animals.

QUT's Mackay Renewable Biocommodities Pilot Plant is located on the site of an operational sugar mill

Case study: Tobacco plants as lifesavers

Project or program title	Newcotiana – Developing multipurpose nicotiana crops for molecular farming using new plant breeding techniques
QUT project team	Science and Engineering/CTCB: Professor Peter Waterhouse, Dr Cara Mortimer, Dr Hyungtaek Jung, Dr Michal Lorenc, Dr Julia Bally, Dr Fatima Naim, Dr Satomi Hayashi Information Technology: Matthew Hodgett
Partner organisations	European Union's Horizon 2020 research and innovation programme
Timeline	2018 to 2022

Why it matters

Australia's native tobacco plant *Nicotiana benthamiana* is renowned as a global plant biology research tool, and can be used as a biofactory for vaccines and pharmaceutical proteins by injecting DNA into the leaves. The plant is used throughout the world by molecular plant geneticists as an experimental host in plant virology. New plant breeding technologies are working to transform tobacco into a next-generation crop variety which can help improve human health.

How the IFE is making an impact

QUT is the sole international cooperation partner in a $10.5 million international research collaboration project called Newcotiana. The project aims to create high-value, non-smoking tobacco varieties, which are able to produce molecules and proteins to create life-saving drugs and vaccines. The project is funded by the European Commission through its Horizon 2020 research and innovation program.

Researchers from QUT's Centre for Tropical Crops and Biocommodities, led by Professor Peter Waterhouse, are creating an advanced toolbox of precise plant breeding techniques for the tobacco plant, including the CRISPR technique.

QUT researchers' work sequencing the genome of Australian native tobacco plant *Nicotiana benthamiana* will underpin project research. The native plant genome has nearly 60,000 genes — twice the number of an ordinary plant. Collaboration in the Newcotiana project allows Professor Waterhouse's team to sequence 100 per cent of the plant's genome using state-of-the-art sequencing and assembly technologies to make a more accurate map of the genome. The team have mapped the majority of the Australian plant's genome using QUT's Central Analytical Research Facility (CARF) genomics lab, eResearch team and High Performance Computing Lab.

QUT researchers plan to release a comprehensive, reference quality open access genome sequence of *Nicotiana benthamiana* in 2019, publishing results on an open source website for the worldwide scientific community at www.benthgenome.qut.edu.au

QUT researchers are sequencing the genome of Australia's native tobacco plant to help produce life-saving drugs and vaccines

Humans of IFE: Julia Bally

"Being able to share ideas with talented experts is always really inspiring. It is exciting to think that the research I conduct could make a difference and possibly benefit the population."

Julia Bally, Research Fellow, Centre for Tropical Crops and Biocommodities

Case study: Developing nutritious, resilient pulses

Project or program title	Tropical Pulses for Queensland
QUT project team	CTCB: Professor Sagadevan Mundree, Dr Brett Williams, Dr My Linh Hoang, Dr Sudipta Das Bhowmik, Dr Grace Tan, Hao Long, Alam Cheng, Grace Weston, Abigail Dawit, Tom Noble
Partner organisations	Associated Grain Pty Ltd, Queensland Department of Agriculture and Fisheries
Timeline	Ongoing

Why it matters

Due to its subtropical climate, Queensland is a major producer and exporter of premium quality tropical pulses contributing significantly to the state's agricultural industry. The Queensland chickpea industry alone contributes 65 per cent of Australia's total crops. Tropical pulses including chickpea and mungbean are nutritionally-rich, high in protein and fibre but low in fat, and are an economical source of protein for food and feed. As the global population increases, so does the demand for plant-based proteins.

Increasing climate variability, including excessive heat and water deficit as well as the increasing incidence of pests/diseases, are major risk factors that limit the expansion and reliability of the Queensland tropical pulse industry.

How the IFE is making an impact

Researchers from QUT's Centre for Tropical Crops and Biocommodities (CTCB) are using innovative biotechnology solutions, accelerated breeding and crop modelling to deliver improved cultivars, enhanced tools and technologies that maximise benefits to the Queensland tropical pulse industry. QUT is partnering with Associated Grain Pty Ltd and Queensland's Department of Agriculture and Fisheries to help strengthen Queensland's position as a global leader of tropical pulses.

Key research areas include:

- developing chickpea plants that are more drought-tolerant, nutritious and resistant to a primary fungal disease called grey mould (botrytis) using genes from a native resurrection grass that tolerates severe drought, salinity and high temperature
- investigating how to make root systems deeper, more robust and more drought-tolerant by pre-treating chickpea seeds with an organic chemical
- genetically mapping a range of mungbean lines and developing a diverse breeding population, including current varieties used in cropping, that will accelerate the national breeding program to provide benefits for mungbean breeders both now and in the future
- tackling the global issue of iron deficiency by developing biofortified chickpea varieties with increased iron, using QUT's Central Analytical Research Facility to measure the micronutrient profile of chickpea seeds
- developing a modelling tool to identify patterns between genetics, environment and management issues affecting chickpea and plants to help farmers implement precision agriculture and risk management.

Chickpea plants under examination in the lab

Research theme: Managing for Resilient Landscapes

Leadership	
THEME LEADER	• Professor Peter Grace
DOMAIN LEADERS	• Sustainable Agro-ecosystems: Dr David Rowlings • Ecological applications: Dr Grant Hamilton
LEADERSHIP TEAM	• 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; Dr David Rowlings • Knowledge to Innovation Broker: Michelle Gane

Real-world context	
KEY TRENDS	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.
GRAND CHALLENGES	• Reducing greenhouse gas emissions and adapting to climate change. • Sustainably producing 50 per cent more food and fibre by 2030. • Maintaining the health of landscapes and ecosystems around the world and reducing the pressure on finite natural resources.

Our research strategy	
IMPACTS	Our research is designed to drive the following changes in the real world: • improved resilience and condition of natural and managed ecosystems • increased resource use efficiency, productivity and profitability • increased ecosystem goods and services.
FOCUSES	We are investigating how to: • develop management solutions at a variety of spatial and temporal scales, from fields to catchments, from days to decades • use state-of-the-art environmental monitoring, simulation and analytical technologies and techniques to develop new management practices • provide cost-effective sustainable development solutions for land managers to increase the productivity and diversity of our ecosystems • maintain the quality of the air, soil and water and different ecosystems.

Research and impact highlights

In 2018, the Managing for Resilient Landscapes theme built on its national and international reputation as a leader in the creation and application of practical solutions for the sustainable development of our environment by securing $6.9 million of external funding. The theme maintained its focus on the acquisition of long-term funding opportunities, building critical mass and collaborations with leading national and international institutions (eg. Columbia University, Michigan State University, University of Florida, University of Sao Paulo, Lincoln University and Karlsruhe Institute of Technology) to ensure the delivery of the highest quality research outputs.

The theme continued to expand its recognised expertise in resource use efficiency in the rural sector, particularly nutrient management for productive and profitable farming enterprises. The theme received one of only 15 highly competitive Smart Farming Partnerships awards in the first round of the Australian Government's National Landcare Program under the Department of Agriculture and Water Resources. By unlocking the true value of organic soil amendments, IFE will develop an innovative, farm-ready tool for the effective management of manures and composts into farm fertiliser budgets for environmental, soil health and economic sustainability. This national project over four years is led by Dr David Rowlings, with collaborators from La Trobe and Deakin Universities and the University of Queensland.

Improved nutrient management is also linked to the reduction of greenhouse gas emissions from agricultural systems, a research area in which the theme has clear national leadership. Sugar Research Australia has funded a new three-year project led by Dr Clemens Scheer, and focused on reducing greenhouse gas emissions from sugarcane soils and developing strategies to increase nitrogen use efficiency and reduce environmental pollution.

An example of the theme's international research profile in greenhouse gas research is a new Asia-Pacific agricultural emissions reduction project funded by the Australian Centre for International Agricultural Research and the Department of Foreign Affairs and Trade.

This project will help the governments of Fiji and Vietnam (as exemplars for the Asia-Pacific region) to develop emission-reduction strategies to meet their international commitments to the United Nations. Led by QUT in collaboration with the Australian National University and the University of Melbourne, the transdisciplinary project team will develop a governance and implementation strategy and provide a detailed analysis of carbon farming options and their potential benefits for small landholders, along with existing capacity gaps and gender considerations.

With the rapid increase in the availability of digital information to the rural sector, a major hurdle is how best to cost effectively use this information to improve on-farm decision making. The theme is now engaged in a major national program, Future Farm Phase II. This four-year project has been funded by the Cotton Research and Development Corporation and Grains Research and Development Corporation in collaboration with CSIRO, University of Sydney, University of Southern Queensland and Victorian Department of Agriculture. The project will develop nitrogen fertiliser management strategies for growers using ground, satellite and UAV-based sensing linked to decision support systems.

The theme has continued its decade-long funding success with the National Collaborative Research Infrastructure Scheme and the Supersite network under the Terrestrial Ecosystems Research Network (TERN). The TERN Supersite network will also form a core part of the Australian Acoustic Observatory led by Dr Paul Roe. QUT has Supersites at the Samford Ecological Research Facility (SERF) and a new site at Longreach.
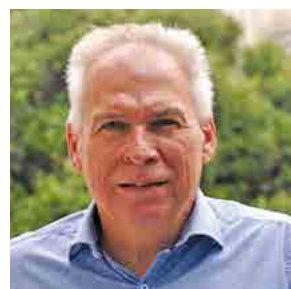
Professor Peter Grace, Managing for Resilient Landscapes Theme Leader

Case study: Creating future farms with nitrogen sensors

Project or program title	Improving farmer confidence in targeted nitrogen management through automated sensing and decision support
QUT project team	Science and Engineering: Professor Peter Grace, Dr Max De Antoni Migliorati
Partner organisations	QUT, CSIRO, University of Sydney, University of South Queensland, Agriculture Victoria, Cotton Research and Development Corporation, Grains Research and Development Corporation
Timeline	2018 – 2022

Why it matters

Efficiently using nitrogen fertiliser is an important goal for cotton and grain growers across Australia. It typically represents 20 per cent of variable costs in irrigated cotton production, and is a major determinant of profitability and productivity. QUT Professor of Global Change, Peter Grace has found that 25-50 per cent of the nitrogen fertiliser applied to cotton and grain farming systems is lost in any season. One way of optimising nitrogen use is Precision Agriculture to deliver the 4 Rs: putting the Right amount of the Right product in the Right place at the Right time. These strategies require substantial investment in time spent processing and analysing digital data from ground, aerial and satellite-based sensors. These steps are not well integrated, and farmer confidence in these tools as decision aids is low given some of the assumptions which underpin them.

How the IFE is making an impact

An important national opportunity in digital agriculture has brought together Australia's best research groups in sustainable food production to improve the way in which soil and crop sensors are used to inform on-farm decisions about nitrogen fertiliser management. The Future Farm Program focuses on the adaptive generation of site-specific management models through increased use of in-season field-monitored data (soil, crop and climate). It does this by using a variety of soil, plant and atmospheric sensors, historic on-farm data, external public and private data and the automation of decision rules in specialist software that

may potentially be linked to real-time application equipment. Professor Grace leads the cotton industry component of this ground-breaking national program which will result in increased profits and productivity across the rural sector.

A 'mother-daughter' field trial model is being employed in collaboration with key grain and cotton groups in northern NSW and southern Queensland. At the core 'mother' sites, field management zones will be identified using remote sensing and yield maps, and multiple nitrogen rate strips will be employed to quantify crop responses to calibrate decision support systems. A purpose-built, portable, low-cost sensor platform for high resolution ground-based data acquisition sensing will be used to complement aerial and satellite-based remote sensing. The on-farm 'daughter' sites (two to three per region) provide diversity in soil type, climate, irrigation management and rotations and are used to validate core relationships and methodologies.

Humans of IFE: Susan Fuller

"I use ecoacoustic technology to listen to our ecosystems to detect biodiversity changes before they become visible. I find this exciting as it enables prompt conservation action and management of impacts."

Susan Fuller
Senior Lecturer in Ecology
Science and Engineering
Faculty

On-field testing of crop monitoring using aerial sensors

Case study: Organic materials for sustainable production

Project or program title	An innovative farm-ready tool for the effective management of manures and composts into farm fertiliser budgets for environmental, soil health and economic sustainability
QUT project team	Science and Engineering: Dr David Rowlings, Professor Peter Grace, Dr Daniele De Rosa
Partner organisations	University of Queensland, La Trobe University, Deakin University, Department of Agriculture and Water Resources, NSW Environment Protection Authority, Meat & Livestock Australia, Cotton Research and Development Corporation
Timeline	2018 – 2022

Why it matters

Adding organic plant or animal material to soil improves its physical properties, such as water retention and structure. Recycling on-farm waste materials to benefit soil is essential for sustainable and profitable farming. However, farmers have found it difficult to account for the value of these nutrients as there is no cross-industry, user-friendly decision support system to provide farmers with the true economic value of organic amendments. Previous research has been piecemeal, with no standard methodology for calculating nutrient availability across studies, crop rotations or industries. This disconnection between end-user growers and producers of these products makes prescribing best management recommendations difficult. A national approach to this problem will ensure standardised data collection across industries and connectivity of organic residue producers with end-farm users.

How IFE is making an impact

A national Smart Farming Partnership project is being led by Dr David Rowlings from QUT's Science and Engineering Faculty to provide innovative solutions in agriculture nutrient management. Funded by the Australian Department of Agriculture and Water Resources under its Landcare Program, this project will establish field sites across Australia's major agro-ecological climatic zones, soil types and industries in Queensland, New South Wales, Victoria and South Australia. The sectors will include intensive vegetable production, broadacre cropping, fodder crops and cotton. A standardised treatment using organic amendments and data collection protocol is used at all sites. These sites will also provide comprehensive on-farm demonstration to farmers on how to reduce mineral fertiliser input costs, while improving yield and soil health outcomes and reducing environmental impacts.

This project has been specifically designed to protect the natural resource base of our soils, air and waterways while improving community awareness and resource management planning and capacity through innovative tools for responsible manure and fertiliser use. It will lead to an increase in farm productivity and resilience to climate and market shocks by reducing nutrient losses, increasing soil carbon and improving soil health and long-term nutrient stocks. The broader community will benefit from reductions in farm nutrient surpluses, nutrient run-off to sensitive waterways, and nitrous oxide generation—a greenhouse gas 300 times more potent than carbon dioxide— as well as increased sequesteration of soil carbon.

The project will provide reductions in greenhouse gas emissions from agriculture to support Australia's response to the Paris Accord. Ultimately, it will provide a market-based incentive throughout the supply chain for the more efficient collection, management, storage and application of this valuable resource.

Researchers using an automated solar-powered sampling system to measure soil-borne greenhouse gas fluxes at Felton, in south-east Queensland

Research theme: Infrastructure for Sustainable Communities

Leadership	
THEME LEADER	• Professor Laurie Buys
DOMAIN LEADERS	• Dr Marc Miska – Mobility • Professor Robin Drogemuller – Energy and Water • Associate Professor Debra Cushing – Future Living • Dr Connie Susilawati – Senior Living
LEADERSHIP TEAM	• Creative Industries: Dr Veronica Garcia Hansen • Science and Engineering: Associate Professor Geoff Walker; Dr Marc Miska; Dr Tracy Washington; Associate Professor Jennifer Firn • QUT Business School: Associate Professor Amisha Mehta; Associate Professor Robyn Mayes • Asset Institute: Adjunct Professor Joe Mathew • Knowledge to Innovation Broker: Mark Gibbs/Raymond Johnson

Real-world context	
KEY TRENDS	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.
GRAND CHALLENGES	• Creating infrastructure that enriches communities while being sustainable, resilient and responsive to climate change. • Developing technology and systems that improve the planning, design and operation of infrastructure. • Developing policy frameworks, funding systems and business models that deliver sustainable, community-centred infrastructure.

Our research strategy	
IMPACTS	Our research is designed to drive the following changes in the real world: • infrastructure that is resilient and provides net benefits to the environment • infrastructure that supports connected and enriched communities • infrastructure models that are financially sustainable.
FOCUSES	We are investigating how to: • optimise the design, construction, performance and security of infrastructure by evaluating how these systems interact, and how future systems should be built and managed • better manage major community infrastructure by developing new methods to understand system behaviour and response • enable faster and safer service delivery, to meet the growing demands of connected consumers, businesses and governments, by developing better networks and infrastructure.

Research and impact highlights

During 2018, the Infrastructure for Sustainable Communities theme focused on identifying challenges and building industry partnerships and alliances.

We kicked off an initiative called Unleashing the Suburban Economy, focused on understanding how to ensure people who live in the suburbs of south-east Queensland are also able to work and benefit from what their local community has to offer (see case study, p24).

QUT is the research partner for Logan City Council's Australian Government Smart Cities and Suburbs grant project studying smart technologies to support flood resistance. This project uses geographic information systems and building information modelling, networks of sensors and data visualisation to help manage flooding events around the Slacks Creek catchment—one of the most vulnerable areas in the Logan City region. The deliverables will support the gathering of live data and real-time analysis to allow engineers and responders to manage flooding events. Responses may include emergency engineering interventions and advice to emergency services on the best routes to travel to incidents.

We also hosted the Senior Living Innovation Challenge, an initiative of Senior Living Innovation (SLI) which is a major research collaboration between IFE and leading industry organisations Bolton Clarke, Aveo and Ballycara. SLI aims to bring to life the World Health Organisation's Global Age Friendly Cities and active ageing principles. Three SLI partners are not-for-profit organisations and all partners provide accommodation and health services to older people. Following the success of the Senior Living Innovation Challenge to uncover game-changing ideas that will empower people over 65 to live life as they choose, we will explore new approaches to offering innovative solutions for the untapped senior market (see Showcase events).

In 2018, In Cahoots, an inter-generational community, held a successful forum to support the creation of innovative solutions and startup ideas for a variety of problems (see Showcase events). Separately, it was agreed to combine the SLI Challenge and In Cahoots to offer a sound inter-generational approach to solving broader industry issues and problems. This work will be further explored in 2019.

Our researchers are working across the IFE's themes on a project to design out plastic waste using an app where, similar to a calorie count app, users will log their daily disposal of plastic (see Materials case study, p41). Data collected from the app will help researchers understand how people use plastic and will inform community and industry co-design workshops to unlock critical points in the plastic consumption-to-waste journey. By connecting general public insights, science innovation and industry capability, our transdisciplinary team expects to propose viable interventions to help change behaviour in relation to plastic consumption and waste.

A project led by Associate Professor Deb Flanders Cushing from QUT's School of Design, and funded by a QUT Engagement Innovation grant, will examine how gamification can boost sensory exploration and environmental learning by primary school students (see case study, p23).

Professor Laurie Buys, Infrastructure for Sustainable Communities Theme Leader

Showcase events

Senior Living Innovation Challenge

Senior Living Innovation Challenge winner, Matiu Bush, explaining his concept of networking with neighbours to reduce isolation among seniors

Australians have one of the longest life expectancies in the world, and the way we age is changing. Launched in late 2017, the Senior Living Innovation Challenge invited entrants to rethink traditional stereotypes of older people and take a new approach to designing communities, products and services for the next generation of Australian seniors. Whether it's housing, digital, technology, services or other innovative concepts, the competition encouraged new thinking and ideas to enable older people to actively participate in their community.

Nurse practitioner Matiu Bush took out the $20,000 Senior Living Innovation Challenge prize for his social networking site One Good Street, which aims to combat senior isolation by matching and connecting older residents with suitable companions who live nearby. The networking site also provides a supported platform for neighbours to offer assistance, knowledge and skills to elderly people. Matui Bush also won the People's Choice Award jointly with Brisbane-based physiotherapist Meg Lowry for her book and app which aim to prevent falls in older people. The announcement was made at a sold-out gala function showcasing the six competition finalists at QUT's Gardens Point campus on 27 February.

Senior Living Innovation is a major research collaboration between QUT and leading senior living industry partners that aims to reconceptualise the experience of ageing in Australia. The research will inform policy development and decision making in the senior living industry by delivering robust evidence, best-practice standards and practical tools for the planning, construction and operation of senior living environments.

In Cahoots: Igniting innovation across generations

In Cahoots was a full-day workshop held in June 2018 which challenged innovators to work in multi-generation teams and develop entrepreneurial business ideas. Hosted by QUT and supported by several industry partners, the event aimed to demonstrate the untapped potential of intergenerational collaboration, with 30 hand-picked, highly motivated participants from five generations. Teams focused on solving a problem from the areas of energy and sustainability; food; waste; transport; and housing and liveability.

Guest speakers included globally renowned innovation expert QUT Professor Michael Rosemann, who shared insights into the latest innovation techniques and strategies. Teams participated in two intensive sessions to identify a problem and conceive and shape a business solution. At the end of the day, groups pitched their business concept to a multi-generational judging panel which awarded prizes for the most outstanding ideas. Visit www.research.qut.edu.au/intergenpower for more details.

A multi-generation team combining their experience and enthusiasm during the In Cahoots entrepreneurship challenge

Case study: Game on for environmental learning

Project or program title	Environmental Education Augmented Reality (AR) Game App
QUT project team	Creative Industries: Associate Professor Debra Flanders Cushing, Mimi Tsai Education: Dr Sean Nykvist, ViseR: Gavin Winter
Partner organisations	Oakleigh State School, 7 Senses Foundation, Playscape Creations, Australian Association for Environmental Education
Timeline	November 2018 – November 2019

Why it matters

Australian kids average just four hours per week playing outdoors and screen use is often blamed as a contributing factor for their lack of interaction with nature. Yet, with growing environmental concerns such as climate change and ecosystem degradation, it is more important than ever that children develop a connection with their natural environment and learn why we must protect it. Primary schools are ideally placed to embrace new technologies that serve an educational purpose.

How IFE is making an impact

Primary students at Oakleigh State School in Brisbane's inner suburbs regularly use digital devices as tools for learning both in and out of the classroom. Using a participatory process, QUT researchers are working with Oakleigh State School and industry partners to develop an environmental education augmented reality (AR) app that fosters sensory exploration and bridges the gap between digital technology and the natural world. The school became involved in this project to support its technology and creative curriculum outcomes and access innovative learning environments that value curiosity, criticality and creative thinking.

The transdisciplinary QUT project team is led by the Creative Industries Faculty and involves the Faculty of Education and IFE's Visualisation and eResearch Lab (ViseR) while engaging several key industry partners including Oakleigh State School, the 7 Senses Foundation, Playscape Creations and the Australian Association of Environmental Education.

This project is funded by a QUT Engagement Innovation Grant and will result in a digital app prototype, a sensory engagement landscape plan and a scoping report for next steps that include additional industry partners and larger grant funding.

> " There are many possibilities for this project to support curriculum outcomes for the students at Oakleigh State School...the use of AR to create an added dimension to the sensory experience is an exciting one. – Nicola Flanagan, Head of Innovation, Oakleigh State School "

Primary schools are ideally placed to embrace new technologies that serve an educational purpose

Case study: Unleashing the suburban economy

Project or program title	Unleashing the Suburban Economy
QUT project team	Creative Industries: Professor Laurie Buys, Associate Professor Debra Flanders Cushing, Associate Professor Markus Rittenbruch, Associate Professor Christy Collis Science and Engineering: Dr Connie Susilawati, Professor Robin Drogemuller, Dr Marc Miska, Dr Tracy Washington Business: Associate Professor Amisha Mehta, Professor Cameron Newton IFE: Andrew Simpson
Partner organisations	Moreton Bay Regional Council, Brisbane City Council, Redlands Shire Council, Logan City Council, SEQ Mayors, Regional Economic Development
Timeline	2018 – ongoing

Why it matters

While inner-city areas and central business districts are important economic hubs, the majority of people in south-east Queensland live in suburbs which provide the services and facilities required for daily living. However, a lack of job opportunities near where people live increases commute times and limits access to meaningful employment, which impacts individuals, families and communities. Local and regional councils in south-east Queensland are working to develop economic development strategies to boost local job prospects, but have questions on how to base their decisions on research evidence and achieve desired outcomes. Increasing employment in the suburbs offers a range of benefits such as better use of existing infrastructure and reducing rates of underemployment, which exist due to travel and family constraints.

How IFE is making an impact

In an effort to unleash the suburban economy and create great places where people are able to live, work and play, an interdisciplinary team led by IFE Infrastructure for Sustainable Communities researchers facilitated a workshop in October 2018 involving numerous city and regional councils and other development agencies. The aim of the session was to identify and prioritise several important issues and begin a conversation on how to boost employment and business growth in the suburbs with IFE's expertise and experience.

Topics and questions raised at the workshop included:

- understanding local factors and the level of amenity
- how to prioritise local advantages and strengths within centres
- forecasting future conditions
- defining and evaluating data.

The workshop was the first stage of a larger process and the IFE team will continue working with government partners to refine research priorities and develop potential projects moving forward.

QUT researchers are working with local councils to boost local employment opportunities for people living in the suburbs

Research theme: Embracing the Digital Age

Leadership	
THEME LEADER	• Professor Marek Kowalkiewicz
DOMAIN LEADERS	• Associate Professor Markus Rittenbruch - Living in the Digital Age • Dr Erwin Fielt - Working in the Digital Age • Dr Paula Dootson - Thinking in the Digital Age • Professor Susan Danby - Learning in the Digital Age
LEADERSHIP TEAM	• Business: Dr Paula Dootson; Professor Uwe Dulleck • Creative Industries: Dr Debra Polson; Professor Axel Bruns; Associate Professor Markus Rittenbruch; Dr Patrik Wikstrom • Education: Professor Susan Danby • Law: Associate Professor Nicolas Suzor; Dr Kylie Pappalardo; Professor Matthew Rimmer • Health: Megan Campbell • Science and Engineering: Associate Professor Richi Nayak; Dr Erwin Fielt • Knowledge to Innovation Broker: Mark Gibbs; Raymond Johnson

Real-world context	
KEY TRENDS	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.
GRAND CHALLENGES	• Identifying and capitalising on the commercial and social potential of emerging digital technologies. • Positioning Australia to export digital services to the expanding Asian middle class. • Developing vibrant tech start-up communities in Australia that can seize the opportunities presented by collaborative consumption and the sharing economy.

Our research strategy	
IMPACTS	Our research is designed to drive the following changes in the real world: • stronger, more resilient and inclusive communities fostered by the digital age • increased value of tech businesses and digitally transformed businesses based in Australia • individuals benefit from digital transformation through reduced costs of living, access to new services and a higher quality of life.
FOCUSES	We are investigating how to: • improve business productivity and profitability by helping organisations to better understand their business, customers and competitors • predict and manage the impacts of emerging digital technologies on individuals, businesses and societies by focusing on legislation, sustainability and privacy • define new business strategies based on digital transformation of products and services.

Research and impact highlights

2018 was a successful and eventful year for IFE's Embracing the Digital Age research theme, with impacts on local, national and global levels. The theme contributed to the **Australian Digital Strategy**, launched in December 2018.

We continued supporting delivery of proactive government services through our collaboration with the Queensland State Government. We also continued building global partnerships — signing a collaboration agreement with Poland's Kozminski University and deepening our relationships with organisations such as Mercedes-Benz North America and SAP Asia Pacific Japan.

We contributed to the largest events in the 'digital space' in Queensland, and hosted key events to profile QUT's digital research.

- IFE's research was displayed to global entrepreneurs, investors and academics through a strong presence at the Myriad Festival (16 to 18 May) — an annual technology, innovation and entrepreneurship event linked to the Queensland Government's Advance Queensland program. This event featured more than 100 speakers and attracted up to 5000 of the world's most influential thinkers and game-changers, including US investors flown in from Silicon Valley. Led by QUT Business School, the university's involvement included an exhibit in the Myriad Garage featuring several IFE projects including the Cartman robot, and Myriad High — an innovation event for 100 senior girls from 20 Queensland high schools, who worked with industry and academic mentors to ideate solutions to cyberbullying (see case study, p27).
- More than 400 people attended The ART of Digital (17 May) in Brisbane to learn more about trust and its impact on digital business models. An all-star cast of thought leaders, representing communities, industry, government and academia provoked and inspired the audience. Speakers included QUT's Professor Marek Kowalkiewicz and Professor Michael Rosemann, together with representatives from Digital Brisbane, SPUR, Girl Geek Academy, Suncorp Group and Microsoft. The successful event was then repeated for the London Tech Festival, with speakers including QUT's Dr Paula Dootson, Everledger CEO Leanne Kemp, Andrew Grill, The Practical Futurist, and Dr Ivano Bongiovanni from Glasgow University.

- We hosted the Three Dimensions of Digital (22 August), an official launch of first-ever Brisbane Digital Confidence Index (see case study, p28) and two additional reports on Digital Maturity of Businesses and Queensland Digital Ecosystem.
- QUT was a leading partner in Something Digital (1 November), sponsoring and contributing content to an inaugural festival to bring together the digital ecosystem from startups and small businesses to government and enterprise.
- We ran the Australian section of a 24-hour global event on the future of work, Virtual World Tour, organised by the Fraunhofer Institute for Industrial Engineering.

Our collaborative research partnerships with government were award winning with the Chair in Digital Economy receiving recognition as part of the following awards:

- Australian Information Industry Association State Merit iAward awarded to Queensland Government, recognising innovation sprints resulting in a new 'MyAccount' proactive service model
- IDC Digital Transformation Award presented to Brisbane's Chief Digital Officer Cat Matson, for work on Brisbane's first digital strategy in 2017.

Law researchers, Dr Kylie Pappalardo and Associate Professor Nicolas Suzor contributed to a report on the State of Digital Rights in Australia. Finally, QUT researchers got the word out about our research at events and via media and podcasts on a range of relevant issues, including technology to prevent self-serve checkout theft, the introduction of Amazon, augmented reality and algorithms.

Professor Marek Kowalkiewicz, Embracing the Digital Age Theme Leader

Case study: Innovation to combat cyberbullying by 2025

Project or program title	Myriad High: The Future is Female
QUT project team	Business: Professor Marek Kowalkiewicz, Dr Paula Dootson, Gemma Alker Creative Industries: Dr Deb Polson
Partner organisations	Girl Geek Academy, Palo Alto, Blue Frontiers, Queensland Government
Timeline	2018

Why it matters

One in five Australian children are cyberbullied, with many of those being young girls. The number of complaints about the online behaviour increased by 63 per cent between 2015-16 and 2016-17, according to the Australian Government's Office of the e-Safety Commissioner.

How IFE is making an impact

To help put an end to the growing problem of cyberbullying and online security, the next generation of female tech leaders were invited to a full-day immersive design and innovation workshop at QUT, on the eve of Brisbane's premier innovation festival, Myriad.

In a rare opportunity for high school students, 100 girls from 20 Queensland schools attended the Myriad High event on 15 May 2018 at QUT's Gardens Point campus. The aim of the event was to provide students interested in science, technology, engineering and maths with professional, technical and entrepreneurial skills to make a difference in the world. With only 12 per cent of workers currently building the internet being women, the event also aimed to build coding skills to level the playing field in tech industries.

Hosted by QUT's Chair of the Digital Economy, Professor Marek Kowalkiewicz, the students worked with world-leading industry and academic mentors to ideate solutions to the problem of cyberbullying by 2025. The groups were coached and mentored by:

- Sarah Moran, CEO of Girl Geek Academy, whose mission is to teach one million women to get into tech and launch startups
- Yael Eisenstal, former CIA officer, national security advisor to Vice President Biden and diplomat turned public advocate
- Shadi Rostami, software engineer and Palo Alto Networks Vice President

- Nathalie Mezza-Garcia, scientist and leader of Blue Frontiers, who ran a project to build a floating island in French Polynesia
- Dr Deb Polson, founder of HUB Student, QUT interactive designer and creator of the GOMA Marvel exhibition.

Small teams of girls worked together to come up with creative solutions to the complex problem of cyberbullying and online security before pitching their ideas to a judging panel. Special guests included Queensland Minister for Innovation, Hon. Kate Jones, Queensland Minister for Education, Hon. Grace Grace, and QUT Vice-Chancellor Professor Margaret Sheil.

First prize was won by a group of students from Queensland Academies Creative Industries (QACI) who presented a concept for a social media campaign called #watchit which could be applied immediately and without funding, based on the Internet response to the #MeToo campaign.

> " Myriad High has given us insights into real-world experiences, and the possibilities in careers in the fields of science and technology. We learnt skills in practical problem solving, and in collaboration." – Chloe Lethbridge-Salt, QACI student in winning Myriad High team

A team of high school girls brainstorm solutions to cyberbullying at Myriad High

Case study: Benchmarking Brisbane's digital confidence

Project or program title	Brisbane Digital Confidence Index
QUT project team	Business: Professor Marek Kowalkiewicz, Dr Md Shahiduzzaman, Peter Townson
Partner organisations	Brisbane Marketing, QUT Chair in Digital Economy
Timeline	2018

Why it matters

When business owners are confident, they invest, grow and change their business. With digital disruption hitting all industries, businesses are trying to cope with the new and emerging challenges presented by a digital era. Technological improvements have disrupted not only products, services and markets, but social and consumer behaviour. New business models and emerging technologies are also shaping the way organisations can transform, and gain or retain competitive advantage. To ensure economic vitality, local governments need to better understand the confidence of businesses to adapt and grow in the digital economy.

How IFE is making an impact

How digitally confident are Brisbane's small- and medium-sized businesses? In 2018, Brisbane Marketing and QUT's Chair in Digital Economy partnered to answer this research question as part of a new Digital Confidence survey, believed to be the first of its kind.

The survey aims to better understand the level of confidence among Brisbane businesses dealing with digital technology and to complement existing metrics on digital readiness, literacy and maturity. To help organisations and individuals thrive in the digital economy, Brisbane Marketing wanted to find out how confident business owners are to go digital, what challenges exist and what can be done to help businesses improve their confidence.

Brisbane Chief Digital Officer Cat Matson said that while digital readiness, literacy and maturity have been measured before, digital confidence research will help build on offerings to assist Brisbane businesses and inform future policy.

Based on a survey of more than 300 business owners, CEOs, senior managers and employees in Brisbane, QUT researchers have been able to establish a 2018 Brisbane Digital Confidence Index to benchmark confidence and explore the extent to which organisational awareness, organisational readiness, execution and leverage impact digital confidence.

The research confirmed the strong enabling role that technology can play to grow a business. More than 90 per cent of the businesses that participated agree that technology enables them to manage their business in a better way. However, more than one-third didn't think that the technology investments and organisational changes have been funded in their business confidently. The research results indicated gaps in digital confidence across organisations depending on their size, sector, maturity, age and type.

Officially launched at the Three Dimensions of Digital event hosted at QUT on 22 August 2018, the Brisbane Digital Confidence Index will help to improve confidence levels when organisations go digital so they are able to thrive in the digital economy, assisting businesses and the economy as a whole.

Brisbane's digital leaders, including QUT researchers, converged at the Three Dimensions of Digital event to launch the Brisbane Digital Confidence Index

Enabling platform: IntelliSensing

Leadership	
THEME LEADER	• Associate Professor Erin Peterson
DOMAIN LEADERS	• Dr Chris Lehnert – Data generation using new technologies • Dr Alan Woodley – Intelligence from sensing • Optimal decision making under uncertainty
LEADERSHIP TEAM	• Science and Engineering: Professor Matthew Dunbabin; Dr Alan Woodley; Dr Grant Hamilton; Dr Kate Devitt; Associate Professor Felipe Gonzalez; Associate Professor Paul Corry; Professor Margot Brereton • Business: Dr Udo Gottlieb • IFE: Dr Marissa Takahashi; Andrew Simpson • Knowledge to Innovation Broker: Raymond Johnson

Real-world context	
KEY TRENDS	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.
GRAND CHALLENGES	• Developing technologies and methods for collecting and analysing large amounts of data to increase situational awareness and gain new insights. • Harnessing key information to make our natural and built environments more resilient, secure and sustainable (socially, economically and environmentally). • Designing sensing and data analysis infrastructure with economies of scale for solving management problems and making critical decisions. • Addressing society's concerns about policy and law governing autonomous movement and sensing technologies.

Our research strategy	
IMPACTS	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: • many industries increase their productivity through IntelliSensing • IntelliSensing enhances decision making for triple-bottom-line (financial, social and environmental) sustainability • new digital–physical markets and businesses are formed.
FOCUSES	• 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. • Creating novel algorithms to automatically process high-velocity and high-volume data. • Understanding spatial and temporal dynamics in complex systems, through the use of powerful data analytics, applied to structured and unstructured data. • Developing innovative decision science approaches to guide decision making and optimise positive outcomes, accounting for uncertainty. • Designing state-of-the-art visualisation techniques to allow governments, businesses, citizens and consumers to more easily access and digest large volumes of data and enhance their decision making. • Understanding and changing limitations of legal and regulatory frameworks to enable the wide application of IntelliSensing solutions across different sectors. • Creating programs to prepare our education sector for developing the future workforce which will develop, deploy, and disseminate IntelliSensing solutions across different sectors.

Research and impact highlights

During 2018, we drove the development of IntelliSensing projects across different sectors, with a strong focus on natural and managed environments, as well as business operations and processes.

Natural and managed environments

The RangerBot autonomous underwater vehicle launched in 2018, after two years of intensive research by QUT Professor Matt Dunbabin and Dr Feras Dayoub. RangerBot is the world's first underwater robotic system designed specifically for coral reef environments, using only robot vision for real-time navigation, obstacle avoidance and complex science missions. Autonomous, affordable and multi-function, it represents a significant technology leap in marine robotics and reef monitoring and protection. It is vitally important to protect reef systems, as more than a billion people depend on coral reefs globally for their food and livelihood. This project is in collaboration with the Great Barrier Reef Foundation with support from the Google Impact Challenge.

As part of a Forest and Wood Products Australia project, Professor Ian Turner and Dr Steve Psaltis developed novel mathematical methods to reconstruct virtual timber logs based on actual tree data. The three-dimensional model enables 'virtual' boards to be extracted from a timber log to predict the structural properties, which strongly influence the timber's commercial value. The new methods will provide growers with much-needed information for enhanced genetic selection, site matching, harvest planning schedules, improved resource allocation to processors, improved tree valuation, and better timber processor settings and product performance.

Business operations and processes

Associate Professor Moe Wynn and her team used process discovery and mining techniques to help Queensland Shared Services (QSS) identify operational efficiencies. This was no small task given that QSS provides finance, procurement, human resource management, telecommunications and mail support services to more than 70,000 public servants across 25 Queensland Government departments and agencies. The QUT team mined more than 4000 process models to discover deviations from established business processes, detect existing bottlenecks and identify candidate processes that could be automated. The results provide QSS with the critical information it needs to boost operational efficiency, leading to cost savings and improved client satisfaction.

Associate Professor Paul Corry and Dr Robert Burdett worked with partner Aurecon to develop algorithms to find scheduling solutions for large dry bulk stockyards, which provide a crucial interface between rail and sea transportation of high-volume export commodities such as coal and iron ore. This problem is critically important to businesses because inefficiencies in loading and unloading trains and ships can result in significant financial penalties. The QUT team is developing sophisticated scheduling algorithms to streamline the allocation and sequencing of tasks related to commodity stockpiles and loading machinery. The goal of this project is to help increase efficiencies at Australian bulk terminals and extend the scheduling horizon by several days.

Catapult projects

Two IFE Catapult projects aligned with IntelliSensing were funded in 2018, both of which address critical societal problems. One interdisciplinary team is exploring how digital technologies could help tag and track human remains so we can identify and treat the victims of death and disaster with respect. This project is a first step towards a robust production-ready system which improves data reliability and the association with human remains, and provides workflows that support users, from first-responders through to pathologists.

The second Catapult project aims to demonstrate how big data and innovative visualisation techniques can be used to manage traffic congestion in real time and support strategic infrastructure planning. This new transdisciplinary team bridges transport domain knowledge, with complementary interactive visual design expertise and human interaction cognition. This project will establish meaningful visuals of the data supporting transport business intelligence, speed up decision making and uncover new business opportunities.

Associate Professor Erin Peterson, IntelliSensing Enabling Platform Leader

Showcase events and initiatives

QUT reef research

Given that 2018 was the Year of the Reef, it was appropriate to highlight the innovative reef research undertaken at QUT. This research reflects QUT's strengths in data science, robotics and computer vision, genomics, governance and policy, as well as the regulation of new technologies to develop innovative solutions that help us understand and sustainably manage reef ecosystems. IntelliSensing research plays a big role in this space, including marine ecosystem modelling undertaken by Dr Paul Wu, using dynamic Bayesian networks to optimise the timing of marine dredging to reduce negative impacts and increase resilience of seagrass meadows. Associate Professor Felipe Gonzalez's work uses drones, hyperspectral imaging and artificial intelligence to monitor coral bleaching on the Great Barrier Reef more quickly, more efficiently and in more detail than is possible using satellites and manned aircraft. QUT's LarvalBots, developed by Professor Matt Dunbabin, were used to distribute millions of coral larvae to damaged reefs as part of an innovative coral restoration technique (coral IVF) with the potential to revolutionise coral restoration worldwide and give managers the technology to undertake these efforts at an unprecedented scale.

Many of these projects also involve students who work closely with industry partners, such as the Australian Institute of Marine Science (AIMS), to develop innovative methods that lead to a better understanding of spatial and temporal dynamics in complex systems. For example, PhD student Pubudu Thilan, with support from Associate Professors James McGree and Erin Peterson, has been working on methods for Bayesian adaptive sampling design that can be adjusted as new data becomes available, are flexible enough to capture unexpected disturbances (eg. crown-of-thorns starfish outbreaks and cyclone impacts), and account for the cost of data collection across a spatially vast ecosystem.

Read more about the diverse reef research undertaken by QUT researchers from the Science and Engineering Faculty, Faculty of Law and Faculty of Education at **www.research.qut.edu.au/reefresearch**

QUT on board with $60 million reef restoration initiative

On 22 January 2018, the Australian Government announced a $60 million investment over 18 months in Great Barrier Reef protection and restoration programs. This includes $6 million to a consortium consisting of AIMS, CSIRO, QUT, James Cook University, the University of Queensland, Great Barrier Reef Foundation and Great Barrier Reef Marine Park Authority to scope and design a major new coral reef restoration R&D program. QUT will provide engineering, robotics, social impact assessment and modelling capability to this program, which will develop the knowledge and technology required to restore coral reefs at scale. This program builds on the existing partnership between QUT and AIMS that led to the Virtual Reef Diver citizen science program and the development of advanced underwater robots for reef monitoring and crown-of-thorns starfish management.

National robotics defence research headquartered in Queensland

A $50 million Defence Cooperative Research Centre (CRC) for Trusted Autonomous Systems will study how autonomous systems, robotics and artificial intelligence can play a role in Australia's future military. QUT helped to bring the CRC to Queensland and is working to establish projects with industry partners.

New technologies to improve natural resources (biodiversity) on Australian cotton farms

This three-year project will be led by the Cotton Research and Development Corporation (CRDC), with collaborators at QUT and UNE. The QUT team includes Associate Professor Erin Peterson, Professor Stuart Parsons, Dr Susan Fuller and Professor Paul Roe from IFE and SEF. The $1.3 million project will help the cotton industry to meet its environmental targets by developing and deploying acoustic technologies to monitor, manage and report on biodiversity at multiple scales.

Case study: Citizen scientists unite to help the Great Barrier Reef

Project or program title	Virtual Reef Diver
QUT project team	Science and Engineering: Associate Professor Erin Peterson, Distinguished Professor Kerrie Mengersen, Dr Ross Brown, Dr Julie Vercelloni, Dr Edgar Santos Fernandez
Partner organisations	ARC Centre of Excellence in Mathematical and Statistical Frontiers (ACEMS), IFE ViseR, Australian Institute of Marine Science, Reef Check Australia, University of Queensland, FrontierSI, Queensland Department of Natural Resources, Mines and Energy
Timeline	2018 – 2019

Why it matters

The Great Barrier Reef is a UNESCO World Heritage listed site recognised for its beauty, expanse and diversity in coral and marine life. It is also one of Australia's most popular tourist destinations and the site of extensive scientific interest. Ensuring its health is critical for protecting the ecosystems it supports as well as protecting Australia's tourism industry. One way to assess its health is to measure changes in hard coral cover over time. However, the sheer size of the reef, at 2300km long, makes it financially and logistically impossible for one organisation to monitor comprehensively. Therefore, new methods need to be employed to measure the extent of hard coral cover over time to inform policy and encourage proactive initiatives to ensure the future health of the reef.

How IFE is making an impact

The Virtual Reef Diver project is a collaboration between scientists, managers, citizens, data scientists, communities and reef operators working together to record, analyse and predict coral cover on the Great Barrier Reef. Led by QUT's Associate Professor Erin Peterson, Distinguished Professor Kerrie Mengersen and Dr Ross Brown, the project taps into the power of citizen science to dramatically increase the amount of monitoring data on the Great Barrier Reef. Analysis of this crowd-sourced data can then be translated into valuable information that managers can use to make better decisions.

IFE's Visualisation and eResearch group (ViseR) developed the online platform for Virtual Reef Diver allowing online citizen scientists to classify images of the reef. Citizen scientists are asked to classify specific regions in the images, specifying which areas comprise hard coral cover. This image-based coral-cover data is then combined with professional monitoring data within innovative statistical models which account for the various levels of data quality, and used to create more accurate predictive maps of coral cover across the entire reef.

The Virtual Reef Diver project was named 2018 ABC National Citizen Science program and received extensive media coverage and engagement from the public during National Science Week. More than 105,000 images were classified by almost 5000 citizens in the first month. Phase two asks citizen scientists and reef divers to upload their own photos of the reef to add to the existing image database for classification. It launched December 2018.

This project was undertaken in collaboration with the ARC Centre of Excellence in Mathematical and Statistical Frontiers and ViseR, with partners from the Australian Institute of Marine Science, Reef Check Australia and the University of Queensland. Funding was provided by FrontierSI and the Queensland Department of Natural Resources, Mines and Energy.

Find out more at ***virtualreef.org.au***

Case study: Australian Cancer Atlas unpacks cancer burden by locality

Project or program title	Australian Cancer Atlas
QUT project team	Distinguished Professor Kerrie Mengersen, Adjunct Professor Peter Baade, Dr Susanna Cramb, Dr Earl Duncan, Professor Joanne Aitken, Dr Upeksha Chandrasiri, Mr Bill Watson, Ms Jessie Roberts, Dr Nicole White
Partner organisations	Cancer Council Queensland, FrontierSI, ARC Centre of Excellence in Mathematical and Statistical Frontiers (ACEMS), ViseR
Timeline	2018

Why it matters

In 2018, an estimated 138,000 Australians will be diagnosed with cancer. Some people face a greater risk of diagnosis and death than others and this is due to a mix of lifestyle, behaviour, genetics and unknown factors. A Queensland Cancer Atlas has existed for some years but a national atlas was needed in order to understand the cancer patterns between metropolitan and rural areas across Australia. This national data drives policy and research with the aim of advancing cancer control nationally by eliminating disparities in levels of cancer care, resourcing and survival which ultimately benefits all Australians.

How IFE is making an impact

Launched on 25 September 2018 in The Cube, the Australian Cancer Atlas is a new interactive digital platform that shows national patterns of cancer incidence and survival rates for 20 of the most common cancers in Australia. The online atlas visually tells a complex story and is designed to help people interpret and understand national cancer statistics. Patterns reflect the characteristics, lifestyles and access to health services in certain areas. The project will give health agencies and policy makers a better understanding of geographic disparities and health requirements across the country. It will also allow everyday Australians to discover the impact of cancer in their local area with free access to the platform online (atlas.cancer.org.au).

The atlas was developed as a collaborative project led by researchers from Cancer Council Queensland, QUT, the ARC Centre of Excellence in Mathematical and Statistical Frontiers (ACEMS) and FrontierSI. The online platform is powered by myGlobe, a digital system developed and enhanced specifically for the atlas by IFE's Visualisation and eResearch (ViseR) team.

The estimates within the Australian Cancer Atlas were calculated using sophisticated statistical models and spatial analyses, developed by statisticians from QUT and Cancer Council Queensland, using data from the Australian state and territory Cancer Council registries. The project was funded by the CRC for Spatial Information, Cancer Council Queensland, the Australian Institute of Health and Welfare and QUT, supported by the Centre for Research Excellence in Prostate Cancer Survivorship and endorsed by the Australasian Association of Cancer Registries and Cancer Council Australia.

The Australian Cancer Atlas, launched in The Cube, is designed to help people interpret and understand national and local cancer statistics

Enabling platform: Transforming Innovation Systems

Leadership	
THEME LEADER	• Professor Rachel Parker
DOMAIN LEADERS	• Dr Rowena Maguire – Technology Ecosystem • Professor Cameron Newton – Innovation Culture • Dr Karen Vella – Social Licence
LEADERSHIP TEAM	• Business: Dr Ozgur Dedehayir, Kim Johnston, Dr Stephen Cox, Dr Carol Richards • Creative Industries: Professor Jean Burgess, Professor Stuart Cunningham, Dr Glenda Caldwell • Science and Engineering: Associate Professor Richi Nayak • Knowledge to Innovation Broker: Mr Raymond Johnson

Real-world context	
KEY TRENDS	It is not inevitable that new scientific knowledge and technologies will take over the market or benefit communities. Our research focuses on the business, organisational, management, workforce and social dynamics which are potential bottlenecks (or drivers of) adoption and diffusion.
GRAND CHALLENGES	• Developing the capacity of Australian businesses, governments and community organisations to change and innovate faster • Designing better governance systems to support community resilience, collaborative decision making and equitable engagement around science and technology. • Creating new industries and value chain opportunities from science and technology. • Ensuring technical research incorporates a stronger focus on human, organisational and societal challenges associated with technological change.

Our research strategy	
IMPACTS	Our research is designed to drive the following changes in the real world: • increased value creation from new technologies and scientific knowledge • more supportive innovation cultures • increased community benefits from science and technology.
FOCUSES	We are investigating: • the key business, social and policy processes that drive the development of new industrial opportunities around new technologies—we map value chains to unpack how market and competitive dynamics impact on the uptake and diffusion of new technologies. • the culture within business, government and society that influence whether people support or oppose new technologies—we develop mechanisms to improve the innovation culture of organisations, the readiness of workplaces for technology change and the quality of public discussion of technology futures. • the effects of technological change on communities and stakeholders, particularly in mining, agricultural, manufacturing and environmental systems—we develop governance processes to engage communities and stakeholders in shaping the outcomes of technology adoption.

Research and impact highlights

It is not inevitable that new scientific knowledge and technologies will take over the market.

Business, organisational, management, workforce and community dynamics can be potential bottlenecks for (or drivers of) adoption and diffusion. This year, IFE's Transforming Innovation Systems researchers built projects to address the challenge of creating value around new knowledge and technologies across a range of industry sectors including mining, agriculture, food and manufacturing.

Our researchers collaborated with the METS Division of the Queensland Department of State Development and Mining3 to fund the establishment of the Centre for Mining Equipment, Technology and Services Business Innovation (CMBI), based in the QUT Business School. Four years of funding will sustain projects on technology ecosystems, organisational culture and change, business models and supply chain coordination to better support the adoption of new mining technologies which improve safety, environmental, community and productivity outcomes.

Platform researchers received funding from CRCORe for a two-year project to explore how stakeholder and workforce management approaches affect the ability of mining firms to adapt in complex environments and achieve both innovative mining and community development objectives.

Professor Rachel Parker was an invited speaker at the Mining & Energy Services Council of Australia (MESCA) Energy Futures breakfast presenting on mining industry innovation challenges alongside the Minister for Natural Resources, Mines and Energy, Hon. Dr Anthony Lynham MP. She also spoke at the Global Mining Group in August and Mining3 Innovation showcase in October.

Dr Stephen Cox collaborated with Professor Ian O'Hara from CTCB with funding from the Rural R&D for Profit scheme to explore the policy, business and community drivers and barriers to the development of Queensland biocommodities industries (see case study, p36).

Associate Professor Karen Vella led participation in the Reef Restoration and Adaptation Program in the area of stakeholder engagement and social licence to operate. She also spoke at the Great Barrier Reef Restoration Symposium in Cairns in July, the Queensland Biosecurity Roundtable in October and the Reef Future Conference in the USA.

Through a range of end-user engagement activities, our platform researchers have co-developed (with industry, government and community), policy, management and business solutions to drive value creation and social benefits from new scientific knowledge and new technologies.

In October, Dr Carol Richards facilitated a public speaker and panel event on fair food systems with partners from the Brisbane Fair Food Alliance and Food Connect which included Dr Eric-Holt Gimenez, Executive Director of the US Institute of Food and Development Policy. Dr Richards was also an invited speaker at the fundraiser for the Mini Farm Project, an organisation that grows food on under-utilised land around Brisbane and donates the food to relief agencies to help feed refugees and asylum seekers.

Professor Jean Burgess, Director of the Digital Media Research Centre, hosted a public panel looking at the future of work with the title, 'Is being a YouTuber a real job?' at which she spoke alongside YouTubers Elly Awesome (who has worked with major brands including Sony, Nintendo, Netflix and Coca Cola), Madison Lloyd (co-founder of YouTube comedy trio SketchShe) and Farhad Meher-Homji (founder of Changer Studios).

Dr Glenda Caldwell was an invited panellist for a UAP webinar entitled 'Robots are Art Machines'. The webinar had more than 70 registrations including from China, USA, Germany and Australia.

Our team has participated in several expert advisory panels. Associate Professor Karen Vella was an invited expert adviser to the Reef Trust Partnership Community Partnerships Working Group for the Great Barrier Reef Foundation, and an adviser on the Queensland Government's Human Dimensions Working Group for the Reef 2050 Water Quality Improvement Plan.

Professor Rachel Parker was a member of the Queensland Department of State Development Mining Equipment, Technology and Services Collaboration Group.

As well as interactive workshops and end-user events, our research has been disseminated widely through media platforms such as The Conversation and in news media including Radio Adelaide and ABC TV in which Dr Carol Richards was interviewed on food insecurity and food waste.

Professor Rachel Parker, Transforming Innovation Systems Theme Leader

Case study: Investigating innovation in Australian biofuels and biorefining

Project or program title	Biorefineries for Profit
QUT project team	Business: Dr Stephen Cox, Professor Rachel Parker, Dr Sandeep Salunke CTCB: Professor Ian O'Hara, Stephen Sinclair
Partner organisations	Sugar Research Australia, Australian Government Department of Agriculture and Water Resources, Queensland Government, Cotton Research and Development Corporation, Forest & Wood Products Australia, Australian Pork Ltd, Southern Oil Refining and NSW Department of Primary Industries
Timeline	2017 – 2019

Why it matters

To address issues of fuel security, climate change and diversification of Australia's agricultural products, the development of a biofuels industry has been the focus of various government policies for 40 years. Agricultural industries have responded to these policies by examining the viability of diversifying into biofuels. Increasingly, there is interest in developing biorefining and bio-based product industries in addition to biofuels developments. Despite these initiatives, growth of an Australian biorefining and biofuels industry has been challenging.

How IFE is making an impact

A transdisciplinary team of QUT researchers are investigating reasons why Australia's biofuel innovation system has traditionally exhibited limited growth and working to develop strategies to counteract these as the current biorefining innovation system develops. This project has analysed Australia's biofuel and biorefining technological innovation systems to identify the primary dynamics that have hindered development of the industries. Research indicates that the diffusion of technology depends on a number of interacting innovation processes operating successfully. While essential to success, the development of the necessary technical knowledge through science-based R&D and the allocation of sufficient financial and other resources does not ensure diffusion of the technology. A range of other innovation processes of a more socio-political nature also need to be addressed. These processes are more difficult to control and address, but are required for the successful development of a technological innovation system.

The study examined the dynamics of the biofuels innovation system over a period of 40 years, which allowed researchers to identify two macro innovation cycles that have repeated over time.

The first has been strong support for science and technology push cycles, initially for first generation biofuels and more recently geared toward advanced biofuels and biorefining. The second macro cycles have been directed toward industrial development. It has been within the industrial development cycles that deficient innovation processes have impacted negatively on the system.

This project is supported by Sugar Research Australia, through funding from the Australian Government Department of Agriculture and Water Resources as part of its Rural R&D for Profit program, the Queensland Government and project partners including Cotton Research and Development Corporation, Forest and Wood Products Australia, Australian Pork Ltd, Southern Oil Refining, NSW Department of Primary Industries and QUT.

Project team member, Dr Stephen Cox from QUT's Business School, at the Rocky Point Sugar Mill

Case study: Gender and climate change in the agricultural sector

Project or program title	Emission Reduction Options in Agriculture: Supporting Nationally Determined Contributions in Vietnam and Fiji.
Research theme or enabling platform	Transforming Innovation Systems and Managing for Resilient Landscapes
QUT project team	Dr Rowena Maguire (Gender and Governance) Dr Max Antoni Migliorati (Mitigation Science) Professor Peter Grace (Project Lead – Mitigation Science)
Partner organisations	Australian Centre for International Agriculture Research (ACIAR) Ministry of Agriculture and Rural Development (MARD) Viet Nam Office of the Minister for Agriculture, Republic of Fiji
Timeline	2018-2020

Why it matters

Women play an important role in the agricultural sector and make important contributions to food security. Globally, there is a trend towards the feminisation of agriculture, resulting in a rise of the proportion of women in the total agricultural workforce. In some countries, the number of women in agriculture is nearing equal levels to men. For example, approximately 45.5 per cent of all women in Vietnam and 42 per cent of all women in Fiji work in the agricultural sector.

The growing feminisation of agriculture means that women will play a large role in mitigating and adapting to climate change. Women will therefore need access to training and financial support to implement climate smart agricultural practices. Research by the Food and Agricultural Organisation shows that initiatives that assist women-headed farms could increase farm yields by 20-30 per cent and raise agricultural output in developing countries by 2.5-4 per cent. Supporting women in these roles thus increases food availability and plays a significant role in growing agricultural incomes.

How IFE is making an impact

Researchers from IFE are partnering with the Australian, Vietnam and Fijian governments to determine options for reducing greenhouse gas emissions in the agriculture sector. The transdisciplinary team combines the scientific expertise of Australia's leading scientist on soil and carbon monitoring and social science expertise on international climate law, land tenure and governance, and gender/climate linkages. The aim of this project is to assist the Vietnamese and Fijian governments to meet their obligations under the Paris Agreement to reduce greenhouse gas emissions.

Globally, emissions from the land use, land-use change and forestry sector account for about 25 per cent of all greenhouse emissions, making emission reduction activities in this sector a priority. Work to date has identified a range of possible mitigation options in the agriculture sector and mapped institutional structures and support to implement such initiatives. Gender-responsiveness in application contributes pro-actively and intentionally to the advancement of gender equality. More than 'doing no harm', a gender-responsive policy, programme, plan or project aims to do better. To ensure climate smart agricultural practices can be meaningfully adopted in Vietnam and Fiji, it is essential that the founding structures of climate smart agricultural policy are gender responsive for future mitigation efforts in the agriculture sector to be viable. Results of this study are expected in 2020.

Enabling platform: Manufacturing with Advanced Materials

Leadership	
THEME LEADER	• Professor Leonie Barner
DOMAIN LEADERS	• Professor Cheng Yan – Metals, Rocks and Inorganic Material • Dr Kathleen Mullen – Organic and Soft Matter • Dr Kateryna Bazaka – Modelling and Digital Manufacturing • Dr Ajay Pandey – Devices, Plant and Installations
LEADERSHIP TEAM	• Science and Engineering: Associate Professor Anthony O'Mullane; Professor Ian Mackinnon; Dr Jennifer Macleod; Professor YuanTong Gu; Associate Professor Prashant Sonar; Dr James Blinco; Professor Prasad Yarlagadda; Dr Soniya Yambem, Professor Jose Alarco, Dr Thomas Rainey, Dr Rafael Gomez, Dr Dongchen Qi, • Law: Dr Hope Johnson • Knowledge to Innovation Broker: Michelle Gane, Ash Amirshahi

Real-world context	
KEY TRENDS	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.
GRAND CHALLENGES	• Minimising the social and environmental impacts of material sourcing, manufacturing, use, recycling and disposal. • Developing high-performance materials with diverse applications across many industries in the digital age. • Catalysing new industries in Australia that capitalise on the country's expertise in materials characterisation and processing.

Our research strategy	
IMPACTS	Our research is designed to drive the following changes in the real world: • more efficient use of resources by global industry • materials which have more environmentally sustainable life cycles • industry sharing the benefits of new materials with communities.
FOCUSES	We are investigating how to: • enhance the performance of materials by changing their electrical, magnetic, thermal and energy-conversion properties • produce higher-quality coatings and films to protect or deliver devices, sensors and surfaces • create new industries through materials design, demonstrating feasible industrial materials production and innovative processing and analytical techniques.

Research and impact highlights

IFE's Manufacturing with Advanced Materials enabling platform had several key highlights during 2018.

QUT is leading H2Xport, a $7.5 million research project to establish a hybrid pilot plant producing hydrogen from renewable energy. Led by QUT Professor Ian Mackinnon, this project is co-funded ($3.35 million) by the Australian Renewable Energy Agency (ARENA) as part of ARENA's Research and Development Program – Renewable Hydrogen for Export and is supported by financial and in-kind support from industry and university project partners.

The pilot plant will be installed at Redlands Research Facility and will use solar energy from the facility's existing Concentrated Photovoltaic array as well as batteries to extract hydrogen from treated seawater. The generated hydrogen will be fed into a fuel cell and back into the grid to re-supply power to the local system (see case study, p40).

Members of the platform also contributed to the stage 1 and 2 bid of the CRC for Future Battery Industries which will position Australia as a globally strategic provider for the future battery industries value chain, and transform the energy sector by leveraging new energy material resources and internationally recognised research capability.

The platform welcomed five inaugural Domain Leaders:

- Dr Kathleen Mullen leads the Organic and Soft Matter domain focusing on transdisciplinary research into functional polymers, wearable technologies, pulp and paper science as well as STEAM education.
- Dr Kateryna Bazaka leads Modelling and Digital Manufacturing, examining 3D printing, materials modelling and simulation as well as system, process and lifecycle modelling.
- Professor Cheng Yan heads Metal, Rocks and Inorganic Material focusing on energy harvesting and storage, inorganic and hybrid materials, materials characterisation and testing, as well as mining and metal processing.
- Dr Ajay Pandey leads Devices, Plant and Installations with emphasis on sensors and bionics, flexible and printed electronics, digital interfaces for human machine interaction, intelligent systems, integration and prototyping.

- Dr Alice Payne heads Strategic Initiatives in Waste coordinating transdisciplinary research between our platform and the Growing the Global Bioeconomy theme. Together, we organised a well-received workshop on sustainable fashion.

In July, Ash Amirshahi joined the IFE team as K2I broker and supports transdisciplinary research in the areas of waste management and space research.

Two IFE Catapult projects aligned with the platform were approved for funding during 2018:

- *Designing out plastic:* Creating innovative ways to reduce and manage plastic waste is led by Dr Manuela Taboada. She and her team are tackling the significant challenge of plastic waste generation by co-creating design systems with stakeholders (see case study, p41).
- Dr Ajay Pandey and his team is tackling the challenges of waste generation through work on a decentralised approach to waste sorting that can be up-scaled and integrated and make recycling more efficient and responsible at the end user level.

Throughout 2018, the platform continued its fortnightly seminar series with well-received lectures from national and international speakers on themes such as macromolecular synthesis and characterisation, organic solar cells, solar energy and composite materials.

The platform also supported several well-attended meetings and workshops, including the Condensed Matter and Materials Annual Meeting in Wagga Wagga, the Global Congress on Manufacturing and Management, the Queensland Annual Chemistry Symposium as well as the IEEE Women in Engineering International Leadership Summit.

Professor Leonie Barner, Manufacturing with Advanced Materials Enabling Platform Leader

Case study: Building on assets with a plug 'n' play hydrogen production pilot plant

Project or program title	H2Xport Project
QUT project team	Science and Engineering: Professor Ian Mackinnon, Professor Anthony O'Mullane, Professor Jose Alarco, Professor Graeme Millar, Professor Ian O'Hara, Professor Peter Talbot, Professor Alex Beliaev IFE: Michelle Gane, Gudrun Seynsche, Katrina Cottrill
Partner organisations	Australian Renewable Energy Agency (ARENA), Sumitomo Electric Industries, Energy Developments Ltd, Swinburne University of Technology, Griffith University, University of Tokyo, Queensland Department of Agriculture and Fisheries
Timeline	Ongoing

Why it matters

Providing the right energy mix is a global challenge and a key issue for Queensland, particularly in regional areas. Queensland is a net exporter of energy products to our northern neighbours and aspires to continue this tradition as the world transitions from sole dependence on fossil fuels to energy efficient renewables-based technologies.

The installation of a concentrated photovoltaic (CPV) system at the Queensland Government's Redlands Research Facility provided an excellent opportunity to value add by establishing a hybrid renewable energy (RE) pilot plant. This pilot plant enables systematic evaluation of hybrid systems to generate hydrogen (H_2) for local use or for export by combining solar and battery power to electrolyse treated seawater.

How the IFE is making an impact

QUT has joined with leading Australian and Japanese companies and universities, with the support of ARENA, in a three-year project to develop new renewable energy technologies with the potential to make Queensland's energy system more efficient, robust and sustainable.

ARENA has provided $3.35 million funding towards this project as part of its Research and Development Program on Renewable Hydrogen for Export. All other partners have contributed an additional $1.9 million in cash and $2.5 million in kind to the project.

Japan has a target to provide 20 per cent of its energy needs using hydrogen by 2035, creating an estimated demand of 10 million tonnes of hydrogen per annum in the future. This demand is exacerbated by Japan's limited capacity to provide solar-intense energy sources for hydrogen production. The cost to produce hydrogen in Australia is a major factor for commercial take-up, so this project will validate and model innovations in the value chain to estimate 'in-field', or real world, costings for hydrogen production in locations with high solar Direct Normal Incidence, waste biomass and non-potable water.

The project will build a benchmarking capacity for key existing, readily available RE components that provide validated data for enterprise-scale economic modelling of performance as well as a platform to test—at small pilot scale—the performance of new technologies developed through this project. Technologies to be developed for hydrogen production include electrolysis, energy storage and gas sensing for integration with the test platform to benchmark against existing commercial standards.

The capability developed will be the first to incorporate CPV and Si-PV solar power networked with energy storage (three different battery types), H_2 production and fuel cell use as well as technologies to generate H_2 from natural resources such as seawater and waste biomass. Expertise from three other leading universities—Griffith University, Swinburne University of Technology and the University of Tokyo—is a vital element of the partnership.

This partnership will complement and boost QUT's existing RE research program, which also includes a micro-grid facility at QUT Gardens Point campus, bioprocessing, and energy storage facilities at the Banyo Pilot Plant Precinct and the Mackay Biocommodities Pilot Plant.
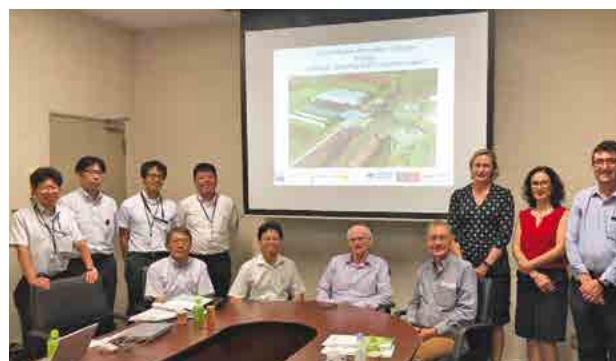
First meeting of key team members in Yokohama in September

Case study: Designing out plastic waste

Project or program title	Designing out plastic: creating innovative ways to reduce and manage plastic waste in Brisbane
QUT project team	Creative Industries: Dr Manuela Taboada, Dr Glenda Caldwell Law: Dr Rowena Maguire, Dr Hope Johnson Science and Engineering: Associate Professor Leonie Barner
Timeline	Ongoing

Why it matters

The world is reaching peak plastic waste in this generation. While reports of fundamental failures in recycling systems are widespread, numerous bottom-up campaigns exist to raise awareness. Meanwhile, global industries and governments lead top-down initiatives. These initiatives commonly overlook sustainable behavioural changes that the public can actively integrate into their daily routines to improve plastic waste practices. This project tackles this challenge by co-creating design systems with stakeholders that can trigger and maintain change in daily habits around single-use plastic consumption and waste.

How the IFE is making an impact

In 2018, a team of transdisciplinary QUT researchers started to combine research, technology and human-centred design methods to collect, map and analyse daily use of plastic by individuals and households. This includes the deployment of community and industry workshops, as well as the development of a mobile app that participants (and the general public) can use to log their daily plastic disposal. This kind of direct data from the end user is unique as waste data (including plastic) is collected at waste management centres after it has been mixed, meaning that it has never been possible to accurately trace disposal habits (and consequent use) to individuals.

Discussions around plastic waste have already generated interest, partnerships and other projects associated with the issue of plastic waste, including a Catapult project to investigate a decentralised approach to auto sorting of recyclable waste by adding intelligence to bins, a QUT bin signage project and media coverage on issues related to plastic waste.

By working within a transdisciplinary and collaborative model, the intention of this project is to go beyond raising awareness towards actual mitigation of the health and environmental impacts of single-use plastic materials. The project aims for ongoing impact through the creation of a network of empowered, connected stakeholders and researchers that can lead and share the future management of plastic from a materials innovation, design, social, and policy perspective. These systems will trigger and maintain a change in daily habits around single-use plastic consumption and waste, based on opportunities and solutions identified within existing approaches to plastic waste at individual, industry, and government levels in Australia.

Handy app to help reduce plastic waste

Researchers are creating an app called ZiP Plastic Count to help people log each piece of plastic they throw away daily. Users will also be able to add information such as: date and time, type of plastic and in which bin the item was put. In turn, the app will give the user personal statistics and disposal patterns, information about which bin is the correct one for each type of plastic, tips on how to reduce the use of each specific plastic item and overview of user progress in relation to reducing plastic. The benefits of the app are two-fold:

- it will help users become more aware of and understand their patterns of plastic use and disposal at the same time as it gives them tools to reduce and change
- data collected through the app will inform the co-design of a larger intervention to change personal and household habits with the aim to reduce plastic waste.

Catapult: Funding to launch QUT transdisciplinary research

IFE's annual seed funding program—Catapult—helps generate and support transdisciplinary research by QUT researchers.

By moving promising transdisciplinary research ideas from creative discovery and application through to adoption by industry or government, our researchers are able to make impact in the real world. We help researchers improve the technology readiness of transdisciplinary projects that can be completed within 12 months.

Fast facts: 2018 Catapult funding

- Two funding rounds
- 41 applications
- Nine new transdisciplinary research projects approved
- $441,720 awarded by IFE

| Project title	QUT project team
GROWING THE GLOBAL BIOECONOMY	
Hydrochar produced from lignin-rich residues as a novel feed and fertiliser improver	SEF/IFE team: **Dr Zhanying Zhang**, Dr Mark Harrison, Dr Kevin Dudley, Dr David Rowlings
A Gummy Bear-inspired manufacturing process to lower the costs of single-administration vaccine delivery capsules to satisfy livestock industry requirements	SEF/Health team: **Associate Professor Tim Dargaville**, Dr Melody de Laat, Professor Kenneth Beagley, Distinguished Professor Dietmar Hutmacher
MANAGING FOR RESILIENT LANDSCAPES	
CropCloud: a cloud-based simulation environment for optimsing agricultural productivity and food security at field to regional scale	SEF/IFE/Business team: **Dr Max De Antoni Migliorati**, Dr Alan Woodley, Professor Matt Dunbabin, Professor Clevo Wilson
EMBRACING THE DIGITAL AGE	
Existing systems, new languages: prototyping blockchain models for the book publishing industry to deliver rights management, royalties and audience engagement	CI/Law/SEF team: **Dr Mark Ryan**, Associate Professor Nic Suzor, Dr Kylie Pappalardo, Professor Arthur ter Hofstede, Dr Suriadi Suriadi, Dr Michael Adams
MANUFACTURING WITH ADVANCED MATERIALS	
Designing-out plastic: creating innovative ways to reduce and manage plastic waste	CI/Law/SEF team: **Dr Manuela Taboada**, Dr Rowena Maguire, Dr Glenda Caldwell, Dr Deb Polson, Associate Professor Leonie Barner, Dr Hope Johnson
A decentralised approach to auto sorting of recyclable waste by adding intelligence to bins	SEF/IFE/CI/IHBI team: **Dr Ajay Pandey**, Associate Professor Leonie Barner, Dr Soniya Yambem, Dr Manuela Taboada, Dr Frederic Maire
INTELLISENSING	
Interactive big data visualisation for decision making: A prototype for mobility data	SEF/CI/IFE team: **Dr Ashish Bhaskar**, Professor Axel Bruns, Dr Dhaval Vyas, Tim Gurnett, Leigh Burgess
When disaster strikes, how can digital technology help us identify its victims?	SEF/Law team: **Professor David Lovell**, Dr Matthew McKague, Professor Margot Brereton, Professor Arther ter Hofstede, Professor Paul Roe
INFRASTRUCTURE FOR SUSTAINABLE COMMUNITIES	
Mitigating urban heat: developing a climate smart toolbox for livable, sustainable precincts to address environmental monitoring and better building design	Business/CI/SEF/IFE team: **Dr Kenan Degirmenci**, Dr Veronica Garcia-Hansen, Dr Sara Omrain, Professor Laurie Buys, Professor Simon Kaplan, Thom Saunders, Professor Keven Desouza

Project leaders indicated in bold.

Catapult: Funding to launch QUT transdisciplinary research

2017 Catapult project update

In 2017, IFE approved six new research projects with a total of $238,419 awarded in two funding rounds. A diverse range of research was funded including extracting value from banana biomass waste, creating cheaper and more effective paper face masks, and identifying and responding to online abuse using machine learning. Several examples are provided below.

Demonstrating effective recycling of fast fashion fibres

With fast fashion creating vast amounts of textile waste globally, new ways to recycle mixed and blended fabrics are needed. This research, led by Associate Professor Robert Speight and Dr Alice Payne, has involved QUT experts in industrial biotechnology, polymer chemistry and fashion working together to identify how single component yarns can be extracted from blended fabrics and then made back into new fabric. The team is working with a commercial partner to conduct a pilot scale demonstration of newly developed textile separation technology for wool and polyester fabric blends at the Mackay Renewable Biocommodities Pilot Plant. This initiative has stimulated significant sustainable textiles activity at QUT, including a sustainable fashion workshop held with industry and government stakeholders in June 2018. Given the demand from the fashion industry, consumers and government, in part due to new waste levies, this project will assist in securing future collaborative research to advance fabric recycling technologies.
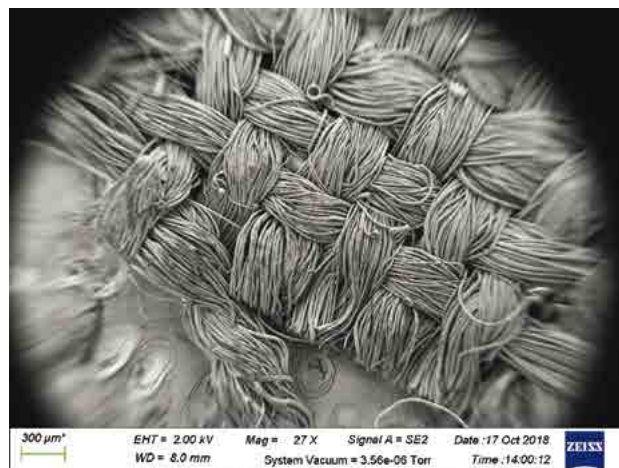
Wool-polyester fabric blend magnified under a scanning electron microscope

Low-cost desalination of impaired water resources for agricultural applications

Agriculture consumes 70 per cent of Australia's freshwater resources. As such, the ability to use salt-laden water such as coastal aquifers in a cost-effective manner is paramount to enable the future growth of the bioeconomy. In this project led by Professor Graeme Millar, researchers from energy and process engineering, business, environmental systems and industrial design worked together to develop innovative technology for low-cost supply of water to agricultural systems by flowing saline water through 'filter pipes' submerged in the soil adjacent to the plants. This technology avoids the use of established water desalination technologies such as reverse osmosis and ion exchange which are costly and complex to use. QUT is seeking to secure venture capital for the filter pipe technology and has secured interest from industry partners in Australia and the USA.

A membrane desalination pipe used in soil irrigation studies

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

Our world-class research infrastructure plays a vital role in supporting research on a scale beyond the reach of individual research groups or disciplines. 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 specialists work closely with researchers and clients to identify and implement the best solutions to real-world problems.

IFE's research infrastructure includes:

- Central Analytical Research Facility (CARF)
- Visualisation and e-Research (ViseR)
- Research Engineering Facility (REF)
- Digital Observatory (new in 2018)
- Banyo Pilot Plant Precinct
- Samford Ecological Research Facility (SERF)
- Mackay Renewable Biocommodities Pilot Plant.

Central Analytical Research Facility

The Central Analytical Research Facility (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.

Research highlights and facility upgrades

- CARF collaborated with Professor Dmitri Golberg in a successful ARC Linkage Infrastructure, Equipment and Facilities proposal for an Atomic Scale-Transmission Electron Microscope. Valued at more than $5 million and housed in custom-designed CARF laboratories (open in 2019), this unique microscope will enable researchers to image any material at atomic resolution while observing its response to mechanical, physical, thermal and optical manipulations.

- CARF supported QUT researchers in 15 applications for beamtime at the Australian Synchrotron in 2018. Under the mentorship of CARF Synchrotron Specialist Dr Michael Jones, more than nine competitive grants (valued at $820,000) were awarded with publications appearing in *Chemical Communications* and other leading journals.

- New methods developed by CARF ion-beam specialist Dr Annalena Wolff enable soft materials and even delicate biological specimens such as collagen to be sectioned at the nanoscale with minimal heat-induced damage. The discovery featured on the cover of the *Journal of Microscopy.*

- CARF's X-ray diffraction team came ninth out of more than 100 international entrants in the Reynolds Cup, an international competition run by the Clay and Minerals Society for quantitative phase analysis.

- In October, QUT agreed to continue to provide metal analysis services to Rio Tinto through to 2023, underpinned by the company's $1.24 million investment in CARF over the next five years to support metallurgical testing.

- Ozone-induced dissociation technology designed and constructed in CARF and deployed to collaborators at the University of Maastricht led to data published in *Angewandgte Chemie* and the subsequent sale of the technology.

- In recognition of her contributions to QUT and her international standing, Dr Charlotte Allen (pictured) was promoted to Associate Professor/Principal Research Fellow. Charlotte and her team contributed to several publications in 2018, including an article in *Nature Geosciences* that provided new understanding of some of the Earth's oldest geological formations.

- Dr Annalena Wolff's expertise in ion-beam physics was central to discovering new ways to transform the fundamental properties of aluminium, which featured in an article in *Nature Communications*.

- CARF Genomic Research Officer, Kevin Dudley was part of the successful IFE Catapult project *Hydrochar produced from lignin-rich residues as a novel feed and fertiliser improver* led by Zhanying Zhang.

Engagement and outreach

- CARF played an important role in IFE's Science in Focus Image Competition, with images representing QUT research captured on CARF instruments entered into the competition (see Engagement and outreach events, p 55).

- In January, CARF partnered with Carl Zeiss to host the second Australian Helium Ion Microscopy (HIM) user meeting, which involved sharing techniques and training by HIM experts from USA and Singapore.

- In July, CARF hosted a group of Indigenous high school students organised by QUT's Oodgeroo Unit and arranged scientific demonstrations and activities ranging from the rheometry of slime to super-conducting magnets.

- In December, CARF hosted the third annual Mass Spectrometry Symposium showcasing mass spectrometry expertise, techniques and technologies, attracting 137 researchers and practitioners from across the state.

- Dr Kevin Dudley was invited to participate in a global initiative for standards in epigenetics, and presented his proposals at a meeting held in California.

Visualisation and eResearch

The Visualisation and eResearch (ViseR) facility provides IFE with the digital pipeline to deliver research and development to stakeholders, clients and the public. The facility leverages advanced computing hardware, audio-visual systems, software tools and development methodologies to lead and participate in projects focused on meeting challenges of data analytics, visualisation, interaction and stakeholder engagement.

Research highlights and facility upgrades

- ViseR delivered an interactive online public citizen science and research platform called Virtual Reef Diver to capture classification data about the Great Barrier Reef (see case study, p32).

- The team designed and delivered the visualisation solution for the Australian Cancer Atlas—the first online, interactive platform showing how cancer diagnosis and survival rates vary across the country (see case study, p33).

- ViseR led the content development for interactive technology at MOD., a landmark science and art venue associated with the University of South Australia. ViseR implemented AV and IT solutions including unique hardware-software tools to deliver a high-impact space and a customised edition of the World Wide Telescope (American Astronomical Society) for public exhibit.

- ViseR played a major role in content development for the Queensland Department of Natural Resources, Mines and Energy Spatial Innovation Hub, as part of research led by Adjunct Professor Steve Jacoby. The Spatial Innovation Hub is a space for users to engage with visualisation and interactive technologies focused on the exploration and analysis of spatial data. ViseR provided expert advice for IT, AV and new technology integration, and developed the Map Explorer, a distinctive multi-user augmented reality (HoloLens) application for collaborative visualisation and annotation of 3D spatial data. This work forms the basis of much of the AR and VR research and development for IFE and ViseR through 2019.

- The Ground Truth project is a collaborative development between ViseR, government, local artists and filmmakers that engages people with the science of remote sensing and earth observation through a large-scale display of imagery and sound. Developed using satellite imagery of three Queensland regions, Ground Truth portrays the impacts humans have had on the environment over the past 30 years. The work was presented at the World Science Festival and other events in 2018, and will continue to be a sought-after piece for STEM and STEAM events at QUT and in wider forums.

- ViseR is working with QUT bluebox to develop a GoToMarket program for its successful spatial data visualisation tools for research, government and industry to converge efforts across projects, leverage QUT IP, and target sectors to grow research and commercialisation potential. The program was awarded a $100,000 grant to bring the myGlobe platform to a commercial product stage, including a business model and company structure to carry the product to market. The myGlobe platform has been adapted for a range of QUT research projects involving master planning of residential property developments (Mirvac Woodlea Wellness Study, Greater Springfield), visualisation of water infrastructure and associated challenges (LGAQ) and visualisation of statistical predictions for fish distribution in Oregon and Washington State (Bonneville Power Administration).

- The QUT Augmented Reality Sandbox platform was extended for Seqwater's 2018 Ekka engagement program. This project features unique integration of computer vision processing and user interaction with physical objects to simulate the capture, storage, supply and recycling of water.

- The Queens Wharf Brisbane Dashboard was developed in collaboration with Queensland's Department of Innovation, Tourism Industry Development and QUT researchers. ViseR provided an online visualisation of localised impacts from the Queens Wharf Casino development.

- ViseR performed as Principal Consultant and Project Manager for Kevin Grove Education Precinct's flagship digital environments, the Sphere and Data Wall, opening February 2019. These projects are globally significant in technology implementation and engagement approaches to teaching, research and industry stakeholders.

- ViseR used its capabilities in data visualisation and digital production to develop 3D models and animations of the 2018 QUT Estate Master Plan to help provide a consistent, collaborative and insightful planning process for stakeholders and contractors.

Research Engineering Facility

Research Engineering Facility (REF) provides specialist, cross-organisational research engineering services in niche domains, such as battery technology research, robotics and autonomous systems, and applied superconductivity. Facility staff are located in three main locations—the Gardens Point campus (battery and robotics), the Banyo Pilot Plant Precinct (battery and applied superconductivity) and the Da Vinci Precinct at Brisbane Airport (including RPAS). Staff are also embedded with industry on specific projects.

Research highlights

- QUT researchers will take an Artificial Intelligence (AI) system on a 1200km road trip through south-east Queensland to ensure the autonomous cars of the future are smart enough to handle tough Australian road conditions. Part of the Cooperative and Highly Automated Driving (CHAD) Pilot run in partnership with Queensland Department of Transport and iMOVE-CRC, the journey involves a driver and an electric Renault fitted with high-tech sensors and computers, and will cover a wide range of roads and driving conditions. REF engineers have developed the research car platform equipped with state-of-the-art camera and Light Detection and Ranging (LIDAR) sensors used on autonomous vehicles. This study will assess the degree to which modern sensors and AI techniques used on automated vehicles can interpret and understand signage and road markings to inform future development and investment in infrastructure.

- Maintaining a huge network of power lines and supporting poles is a daunting but critical task. Electric network outages cost $160 billion globally each year. The energy industry has been deploying Remotely Piloted Aircraft Systems (RPAS or drones) for power network inspection within preventative maintenance practices, but improvements in autonomous drone technology will amplify these benefits. REF has been involved in sensor and perception technology and control, and inventing autonomous drone technology for easier, faster and more reliable power pole inspection. The project team successfully developed lightweight pilot assist technology using computer and machine vision to automatically detect a drone's distance from, and relative location to, power poles and wires.

- In partnership with the Queensland Department of Environment and Heritage Protection, QUT researchers have developed an innovative method for detecting koala populations using drones and infrared imaging that is more reliable and less invasive than traditional animal population monitoring techniques. REF supported the research through 14 days of pre-dawn flights, with each day of operation typically covering 46ha over 3.5 hours. More than 500GB of data was collected daily, which was then post-processed and supplied to the research team for further analysis.

Outreach and engagement

- QUT was a major sponsor of the 2018 World of Drones Congress that brought together industry and government leaders with drone experts and enthusiasts to discuss, display and explore all things drone-related. The 2018 congress focused on the burgeoning commercial applications of drones, including planning smart cities, training, agriculture, health and humanitarian needs, as well as drone laws, regulation and new jobs for the future. QUT researchers provided expert commentary as panellists on the National Drone Safety Forum, discussing the frontiers of drone technology and the use of drones in environment, research and industry, in addition to giving the opening plenary. Many of these topics are supported and enabled by the RPAS team within REF.

- The REF team were integral members of the UAV Challenge, the world's biggest airborne robotics challenge jointly organised by QUT and CSIRO. Held in September 2018 in Dalby, the event featured both the high-school student Airborne Delivery Challenge, and the biennial Medical Express Challenge for enthusiasts and university students. The competitions attracted 23 teams from eight countries competing for more than $85,000 in prize money.

Digital Observatory
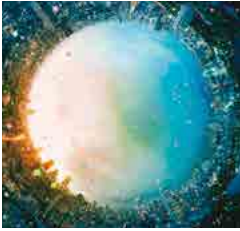
The IFE-hosted QUT Digital Observatory was established in January 2018, and launched in August to provide state-of-the-art research infrastructure for tracking, collecting and analysing large sets of continuous and dynamic digital data. This capability allows researchers of all disciplines and stakeholders to undertake innovative digital media and society research with applications across a range of fields. The Digital Observatory provides researchers with access to the Australian Twitter Collection, which includes tweets from all identified Australian accounts, collected since 2006. This collection is based on research data infrastructure developed through the TrISMA (Tracking Infrastructure for Social Media Analytics) ARC LIEF project (2014-16).

Throughout 2018, establishing the facility has involved conducting comprehensive user research and establishing governance. The growing team consists of a manager and two highly skilled software developer/data scientists.

Research highlights

- The Digital Observatory conducted an IFE Horizon Scanning Project, to identify current and emerging trends in research and innovation across several disciplines in the social media landscape to guide the IFE's direction and investments.
- The Digital Observatory collaborated with IFE's ViseR team to visualise three research projects from Creative Industries, Science and Engineering, and Law.
- The facility has supported QUT research projects, including:
  - Amplifying Public Value
  - Understanding Intermedia Information Flows in the Australian Online Public Sphere
  - Journalism beyond the Crisis: Emerging Forms, Practices and Uses
  - Music Usage Metrics and the Future of the Australian Music Industry.

- Three major universities have partnered with the Digital Observatory, including Deakin University, Curtin University and the University of South Australia.
- The facility supported several early-career researcher and PhD projects related to topics including text mining, journalism, social news, network analytics and tree mining.
- The facility supported Damien Spry, a Visiting Fellow researching public communication metrics from public Twitter data.

Outreach and engagement

- Digital Observatory research leader Professor Axel Bruns presented and demonstrated the TrISMA Australian Twitter Collection at the University of Sydney and the Association of Internet Researchers Conference in Montreal.
- Digital Observatory Manager Marissa Takahashi presented at the Australian Social Network Analysis Conference at Australian National University in Canberra.

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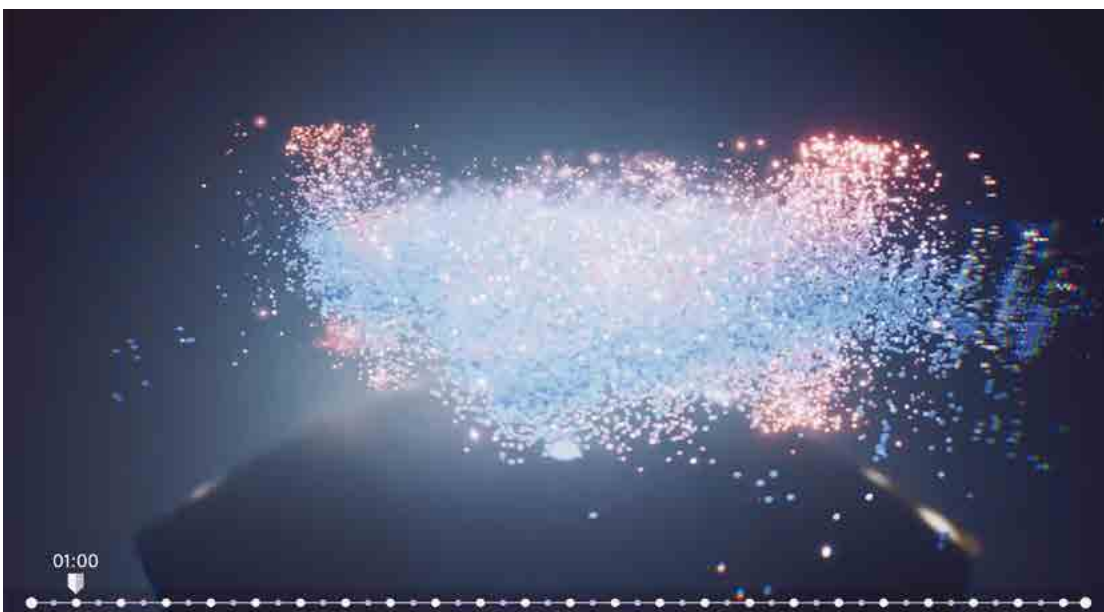
Make this image come alive. See inside front cover for details.

Banyo Pilot Plant

The Banyo Pilot Plant is located a short drive from the Gardens Point campus in a light industrial precinct. Hosting specialised labs, workshops and large-scale engineering infrastructure, it offers a transdisciplinary approach to full-scale academic, industrial and student research. Built environment, structural and mechanical testing is conducted on the well-equipped, purpose-built strong floor, facilitated by a technical team and vast array of technical engineering equipment for the design, manufacture and implementation of product and material testing and validation. Electrical testing, geological analysis, thin section production, aquaculture and an environmental chamber are just some of the facility's capabilities. Research projects undertaken include the development of pilot equipment and processes, as well as long-term monitoring of industrial products.

Research highlights

- A project to develop, install and operate a membrane distillation pilot plant to process brine/salt water with Japanese chemical company Asahi Kasei is being led by Professor Graeme Millar.
- Higher degree research students undertook 16 projects, investigating topics such as:
  - fire performance of steel-framed building structures, wall boards and cement block walls
  - stress loading on experimental steel structures, roof panels and wall structures
  - surface movement of expansive soils
  - freshwater prawn lifecycles and eDNA degradation in freshwater environments.
- Six diverse academic research projects were conducted in the following areas:
  - domestic lighting performance
  - high-temperature superconductivity performance and telemetry systems
  - lithium-ion battery electrode manufacture and battery fabrication
  - design, development and fabrication of a high-velocity impact test rig
  - sugarcane processing and bio-oil production.

Outreach and engagement

In 2018, the facility hosted 10 site visits from a range of industry and government representatives including BMW, CSIRO, CS Energy, Royal Australian Navy, Australian Solar Thermal Research Initiative, Japan External Trade Organization and Qingdao University of Technology.

Professor Peter Talbot and his team investigate new battery technologies at Banyo Pilot Plant
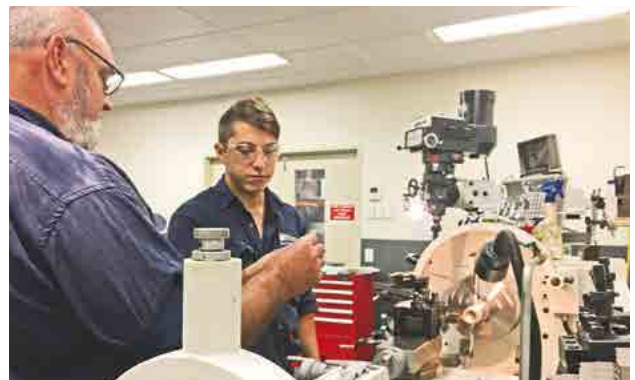
Glenn Atlee training apprentice Zeph Kadel on using the metal lathe

Samford Ecological Research Facility

Samford Ecological Research Facility (SERF) is located in the Samford Valley, about 25km north-west of QUT's Gardens Point campus in Brisbane. This 51-hectare property provides QUT with a research, teaching and learning base for a range of ecological, engineering, built environment and educational programs primarily relating to urban development and its impact on ecosystems.

Research highlights

- Continued environmental monitoring and data collection at SERF contributed to Australia's national ecosystem research infrastructure, TERN. Information on energy, gas and water flows are measured through an onsite flux station, and biodiversity information is surveyed at a core vegetation plot. This data contributes to improved national and international understanding of ecosystem dynamics and climate, including helping to improve Australia's national climate models that inform our daily weather forecasts.

- SERF is a foundational site in the new Australian Acoustic Observatory (A2O). The A2O is a continental-scale bioacoustic sensor network that will help to monitor animal populations across the continent at more than 400 locations. The custom-designed acoustic sensors have been field tested and refined at SERF, and are now ready for roll out across Australia.

- SERF's insect enclosures have been used by QUT researchers to investigate the potential role of bees as vectors of myrtle rust.

- SERF is a critical long-term study site for QUT research into the genetics and ecology of the antechinus, a unique Australian marsupial, which is a model of rapid ageing. During field work for this research, a Common Dunnart (with babies) was detected at SERF for the first time ever.

- SERF hosted higher degree research students conducting:
  - visual and acoustic surveys on bird species
  - unmanned aerial vehicle operations collecting data with a robotic platform
  - conservation biology of the threatened native olive species (genus Notelaea) in southern Queensland.

- Undergraduate student fieldwork programs brought students from across biology, environmental science, and engineering to study topics ranging across ecosystems and the environment, remote sensing and soil science, experimental design and quantitative methods, vertebrate biology, insect biology, conservation biology and invasion ecology, environmentally sustainable design, environmental law, and the application of unmanned aircraft systems to air quality testing.

Outreach and engagement

- As part of QUT's Sustainability activities led by Facilities Management, a reforestation project commenced in May 2018. Ten eager QUT undergraduate students assisted in planting 335 native trees, plants and shrubs in the south-west corner of the property adjacent to Samford Creek. Restoring riparian vegetation is especially important for stabilising creek banks and improving water quality.

- Other groups visiting the site included UQ Masters of Architecture students and 100 delegates from the National Ecoacoustics Congress. Marks family members also visited the facility for lunch at the Barracks to commemorate Pat Marks' 100th birthday.

- The annual SERF information evening was attended by about 50 local Samford residents who learned about facility operations, undergraduate teaching field trips and research activities conducted at SERF over the year.

QUT staff and students join forces to reforest SERF by planting 335 seedlings to rehabilitate a 1950m^2 patch of land next to Samford Creek

Mackay Renewable Biocommodities Pilot Plant

The Mackay Renewable Biocommodities Pilot Plant converts agricultural plant waste into renewable transport fuels (bioethanol), green chemicals and other high value biocommodities. There is no equivalent biorefinery pilot plant in Australia. Large-scale fermentation also supports scale up of industrial biotechnology processes. It provides infrastructure at the pilot scale that links product and process innovation with commercial viability assessment.

Research highlights

- A 'Biogas from sugarcane' project funded by the Australian Renewable Energy Agency (ARENA) in collaboration with Griffith University and industry partners commenced in 2018. This project aims to develop pilot-scale processes to produce biogas from sugarcane trash and bagasse by using anaerobic digestion. It will also test ways to upgrade biogas for transportation fuels.
- Singapore biotechnology company CocoNutZ worked with QUT researchers and the pilot plant team to explore fermentation and other processing techniques to produce a marketable product from locally produced sugarcane juice.
- Researchers from QUT's Centre of Tropical Crops and Biocommodities undertook a suite of projects to investigate the pre-treatment of bamboo, cotton gin trash, rice straw, bagasse, sugar cane trash and sweet sorghum biomass materials for conversion into more valuable food, feed, fibre, fine chemical and fuel products. One project also involved fermentation of *Mortierella* fungus for bio oil production.
- The fermentation facility within the pilot plant was refurbished for operation at OGTR-certified Large Scale PC2 containment level, opening a range of new options for research activities at the site.

Outreach and engagement

The facility hosted visits by several government and industry representatives during 2018, including:

- Assistant Minister for State Development and Member for Mackay, Julieann Gilbert
- Queensland Trade Commissioner for Brazil with Trade Commissioner for Indonesia, Alex Pessagno
- Queensland Department of State Development, Manufacturing, Infrastructure and Planning
- Mackay Regional Council
- Life Sciences Queensland
- Queensland Renewable Fuels Association
- GFG Alliance.

Humans of IFE: Geoff Kent

"The sugar industry is one of regional Queensland's most important industries. It is continually facing competition on the world market and I'd like to think my work is helping to improve the sustainability and profitability of the industry."

Geoff Kent, Principal Research Fellow Centre for Tropical Crops and Biocommodities

TRANSDISCIPLINARY RESEARCH CULTURE AND SUSTAINABILITY

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

Engagement and outreach

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.

Events

IFE runs lectures, workshops, forums and other events to foster a culture of research excellence and transdisciplinary collaboration at QUT and to forge links with industry, government and the community. In 2018, IFE presented 10 Grand Challenge Lectures, 18 Distinguished Visitor Lectures, many seminars and industry-focused workshops, and IFE's fifth annual scientific image competition, Science in Focus.

Grand Challenge Lecture Series

IFE's successful Grand Challenge Lecture Series explores the major challenges confronting humanity in the 21st century and investigates possible solutions. This popular series has been running for five years, having been introduced in 2013. In 2018, IFE presented 10 lectures by eminent speakers on a wide range of challenges facing our world. QUT's Vice-Chancellor, Professor Margaret Sheil presented in May. Over the year, the lectures reached more than 1600 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. These lectures are recorded and published online as videos and audio podcasts.

Grand Challenge Lecture speaker, Ronni Kahn, CEO of OZHarvest spoke on the global challenge of food waste

Grand Challenge Lecture	Speaker
1. Next generation nanomaterials for therapy and diagnostics	Professor Tanja Weil (Max Planck Institute for Polymer Research, Germany)
2. Innovation must become the core of national priority settings	Bill Ferris AC (Chair, Innovation and Science Australia)
3. Provoking intergenerational change – empowering a generation to close their own gap	Wayne Denning (Managing Director, Carbon Creative)
4. Backing Australia's research ecosystem	Professor Margaret Sheil (Vice-Chancellor, QUT)
5. Domino's journey… where to from here?	Don Meij (CEO, Domino's Pizza Enterprises)
6. The 21st Century transport challenge	Hugh Bradlow (President, Academy of Technology and Engineering)
7. Great Barrier Reef Challenge Lecture: Working together to secure the future of our national icon	Speaker panel, facilitated by Robyn Williams from ABC's The Science Show
8. Engineering a revolution: from impossible complexity to transformed lives	Hon Trish White (National President and Board Chair, Engineers Australia)
9. Food is about health care, medicine is about sick care: the importance of plants in our diet	Professor Cathie Martin MBE FRS (Plant Biologist, John Innes Centre, UK)
10. Harvesting passion: From identifying a problem to finding a solution	Ronni Kahn (CEO and Founder, OzHarvest)

Engagement and outreach

Distinguished Visitor Lecture Series

In 2018, IFE hosted 18 lectures in its Distinguished Visitor Lecture Series, which gives experts from academia and industry a forum to discuss the key trends, issues and opportunities in their fields. Each of the 2018 lectures—which covered a diverse range of topics connected to IFE's research themes and enabling platforms—were attended by 35 people on average.

The diverse range of lecture topics included materials science, coral bleaching, nanothreads, autonomous systems, the agri-food value chain, renewable energy, chemistry, behavioural and data science, and coral bleaching on the Great Barrier Reef. Visiting global experts from Japan, China, America, Scotland and Sweden shared their expertise. The series also featured national speakers from other Australian universities, Australian Institute of Marine Science, Source Certain International and CSIRO. In July, IFE hosted a Royal Australian Chemical Institute Margaret Sheil Medal Lecture to champion women in chemistry.

IFE seminars

IFE hosted 29 IFE seminars in 2018, including the active Manufacturing with Advanced Materials fortnightly seminar series. The CTCB also hosted an additional 32 events as part of its popular weekly seminar series. Academics from international and Australian universities and industry organisations took part in the various IFE seminars, which are specialised presentations designed to share research, ideas and concepts with academic peers, staff and students.

Listen back to 2018 lectures on IFE's podcast and QUTube channels by visiting www.qut.edu.au/ife

Research 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 in 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.

World Science Festival

QUT was a major academic partner of the 2018 World Science Festival held in Brisbane from 24 to 25 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. IFE researchers were involved in sharing their expertise across the program in areas including robotics, autonomous driving, and science and mathematics.

QUT Giving Day

IFE was involved in QUT's first Giving Day on 22 May, inviting staff, students, alumni and and wider community to come together for 24 hours to 'help change the world in one day' by supporting vital QUT programs and research. The event raised in excess of $1.6 million to support more than 20 projects, including IFE research projects to protect the Great Barrier Reef.

Science and art collide: QUT Science in Focus Competition

Science in Focus is an annual competition hosted by IFE to celebrate striking and unexpected images or videos that illustrate the impact of QUT research. In 2018, more than 120 original entries were submitted by QUT students and staff. This year's winners included an image revealing the hidden beauty of a rat bone by lab technician Dr Kah Meng Lee and a spectacular video of a fluorescent dye filtering sea sponge by coral researcher Brett Lewis. Second place went to Dr Jayanti Mendhi for her image Flossed, which provided a unique perspective of dental floss magnified 500 times. As part of a finalist exhibition and award ceremony on 19 October, competition images were projected on to The Cube. To celebrate the fifth year of the competition, IFE also collaborated with Creative Industries to develop a curated visual installation, featuring a selection of past and present entries set to music. This large-scale art and science installation featured as part of the QUT CreateX festival from 15 to 17 November, with visitors able to view stunning scientific imagery by talented staff and students on Creative Industries' new digital canvas.
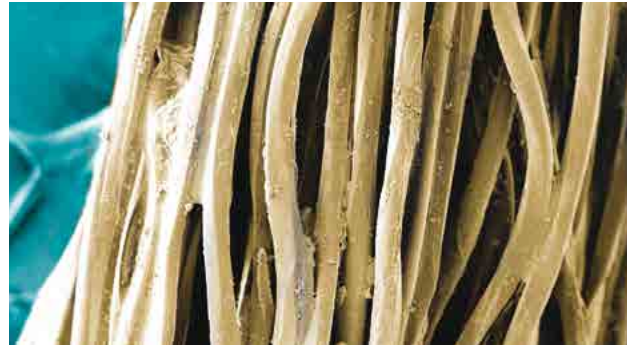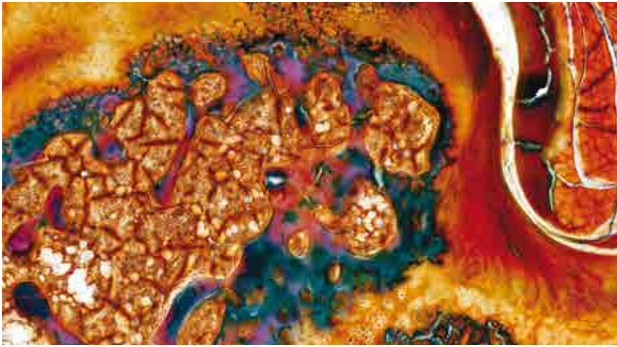
Make this image come alive. See inside front cover for details.

Learning and teaching programs

QUT aspires to provide outstanding real-world education programs and produce highly skilled, enterprising graduates. Although the university's education programs are primarily managed by its six faculties, IFE supports these programs in various ways, particularly by teaching and training students from the Science and Engineering Faculty (SEF) and exposing them to the research activities and facilities of the institute.

IFE has more than 30 academic staff within its Centre for Tropical Crops and Biocommodities (CTCB), many of whom teach in SEF undergraduate subjects or supervise Honours or capstone projects. The institute also has a group of academic staff within its research facilities, some of whom teach in SEF subjects or supervise SEF students.

IFE's largest facility, the Central Analytical Research Facility (CARF), supports the education of SEF students by teaching them the principles and techniques of a wide range of specialised analytical technologies, from electron and optical microscopy to genomics and proteomics. In 2018, CARF trained 125 PhD, 26 Masters, seven Honours and 19 undergraduate students to use CARF equipment. As well as training students to use specific machines and interpret the data they obtain, CARF staff run seminars that explore the broader capabilities and potential of particular technologies.

Another IFE facility, the Samford Ecological Research Facility (SERF), a 51-hectare living laboratory in the Samford Valley, gives undergraduate students an opportunity to conduct experiments in the field and gain practical research experience. Hundreds of SEF students from the environmental sciences, biological sciences and engineering visited SERF in 2018 to study the soil, animals, plants and insects and learn skills in planning for sustainable urban development.

IFE also develops and delivers some of QUT's professional education programs. CTCB, in partnership with the Sugar Research Institute, is the trainer of choice for the Australian sugar industry. CTCB engineers provide high-quality training courses and workshops, at QUT and at sugar mills around Australia and overseas, to help sugar mill operators and managers to improve factory performance and operational efficiency. In 2018, the CTCB delivered about 280 people days of training and released online training modules to complement their face-to-face training workshops. The online programs satisfy the national competency requirements for training in each of the required factory unit operations.

QUT students from the School of Earth, Environment and Biological Sciences studying in the field at SERF

Media

During 2018, a wide variety of local, national and international media outlets ran stories about IFE researchers, projects and events.

TOP STORIES FOR 2018

Robot reef protector provides new way to check Great Barrier Reef health

The September launch of an innovative robotic reef-protector RangerBot by QUT Professor Matt Dunbabin gained widespread national and international coverage including ABC News, 7 News, 9 News, 10 News, Smithsonian, Agence-France Presse, ABC Radio Sydney Drive, 2SER Radio, The Star Online Malaysia, Yahoo USA, and Lonely Planet. Developed as a result of a collaboration between QUT, Google and the Great Barrier Reef Foundation, RangerBot is an underwater drone that can keep watch on reef health and accurately identify and inject the devastating crown-of-thorns starfish on the Great Barrier Reef. In December, QUT also received significant media coverage about LarvalBot, a re-engineered underwater robot able to disperse coral larvae on to the reef in a world-first pilot to help restore and recover coral reefs.

Renewable jet fuel and diesel made from sugarcane waste

In February, it was announced that QUT is testing a novel technology developed by US company Mercurius Biorefining to convert biomass such as sugarcane bagasse into jet and diesel fuels. The Mercurius biofuel project gained media exposure for the QUT Centre for Tropical Crops and Biocommodities, including coverage on 10 News Queensland, Australian Manufacturing, News Corp, 9 News Mackay and 7 News Mackay.

Media

Media highlights in 2018

Date	Topic	Researcher/s	Media outlets
Jan/Feb	Oil from recycled tyres as fuel	Associate Professor Richard Brown	Courier-Mail, Perth Now, The West Australian, Fairfax regionally, Yahoo 7, KRock FM Radio Geelong, Bay FM Radio Geelong
	Senior Living Innovation Challenge	Professor Laurie Buys	Aged Care Insite, ABC North Queensland Mornings, Australian Ageing Agenda, Aged Care Online
Mar/Apr	QUT report on biofuels as the gateway to Australia's bioeconomy	Professor Ian O'Hara	Fairfax Media, Australian Manufacturing, Queensland Country Life, The Land, Farm Online
	Lab-grown meat	Dr Hope Johnson	The Conversation, Modern Australia, View magazine, Daily Bulletin, Australian Business
	Harvey the capsicum-picking robot	Dr Chris Lehnert	BBC Technology
	QUT's collaborative research project using remote-sensing technology to help in the fight against vineyard pest phylloxera	Associate Professor Felipe Gonzalez	Australian Community News Regional Network, Fairfax Regional Media, ABC Radio Victoria Country Hour
Jul/Aug	QUT research on turning waste sugarcane bagasse into livestock feed	Associate Professor Rob Speight, Dr Mark Harrison	ABC TV Landline, ABC News, msn.com
	Research to develop a floating 'Drifter' device to capture real-time river flow and water quality	Professor Richard Brown, Dr Kabir Suara	ABC TV, radio and online platforms, SBS News, Yahoo NZ, China.org, Fairfax Media, Courier-Mail
	New material to deliver highly efficient, stable and considerably cheaper solar technology	Associate Professor Prashant Sonar	7 News, 9 News
	More funding needed for pure research	Professor Margaret Sheil	The Australian, Campus Morning Mail, Times Higher Education
Sept/Oct	Australian Cancer Atlas developed by QUT, Cancer Council Queensland and FrontierSI launched at The Cube	Dr Erin Peterson	News Corp, ABC Radio AM, 7 News, Sky News, 9 News, 10 News
	QUT leads project to establish a pilot plant producing hydrogen from renewable energy	Professor Ian Mackinnon	Gizmodo, MSN, Breitbart USA, Global News Connect, Xinuanet, Newsline, Science Alert, The Conversation, Australian Geographic
Nov/Dec	Robots makes world-first baby coral delivery to Great Barrier Reef	Professor Matt Dunbabin	ABC, MSN, NBC News, TechCrunch, CNet, Reddit, Techly, Computer World, Business Insider, Irish Times

QUT Professor Richard Brown and Dr Kabir Suara, with the Drifter devices they have developed to measure water flow and quality

DIGITAL AND SOCIAL MEDIA

>20000
Website
VISITS

>2000
Twitter
FOLLOWERS

•298•
Instagram
FOLLOWERS

1716
Flickr
PHOTOS

1615
QUTube
VIEWS

IFE website (www.qut.edu.au/ife)

The IFE website contains detailed information about IFE's research programs, centres and facilities, as well as our events for the general public, staff and industry. Visitors to the site continue to grow, with the site attracting more than 20,000 visitors during 2018 (up 67 per cent from 12,000 visitors in 2017).

Twitter (@IFE_QUT)

Twitter has been a significant engagement channel for IFE. We tweeted at least once a day throughout 2018, sharing news of research activities and achievements, upcoming events, new equipment and interesting articles and blogs relevant to IFE's research areas. By December 2018, IFE's Twitter account had attracted 2026 followers—an increase of more than 500 followers from 2017.

Instagram (@ife.qut)

IFE established a new Instagram account in 2017 to further profile its research, events and achievements through images and video. By December 2018, the account had 298 followers—tripling in size from the same time the previous year.

Flickr

In 2018, our Flickr collection grew to 1716 photos 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 the Elo Life Systems Australia lab launch, The Australian Cancer Atlas launch, the QUT Science in Focus competition, the In Cahoots Intergenerational Challenge, and the Sustainable Fashion Workshop.

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. Currently, we have 96 videos with a total of 1615 views.

Podcasts

Last year, IFE introduced a new podcast channel via iTunes and by the end of 2018, had 30 lectures, seminars and presentations uploaded. In total, there were 120 downloads and 95 streams with the most popular downloaded lecture being 'Supporting urban agriculture with research to improve food security' by Dr Cathryn O-Sullivan, CSIRO Agriculture and Food.

Awards and scholarships

Awards and scholarships sponsored by IFE

Siganto Foundation Medal: Dr Christoph Meinert
The 2018 annual Siganto Foundation Medal was awarded to Dr Christoph Meinert, an outstanding early-career QUT researcher displaying excellence in engineering research. Funded jointly by IFE and The Siganto Foundation, the winner receives the medal along with $10,000 for transdisciplinary professional development and research activities. Christoph's PhD involved the development of a novel mechanical bioreactor, development of new biomaterials and evaluation of new engineered cartilage tissues. This work involved skills in many different areas, including hardware and software design, materials science and engineering, biomechanics and mechanobiology, and cell biology. Christoph is co-founder of Gelomics Pty Ltd, a Brisbane-based biotech company that is developing and distributing biomaterials and kits for 3D cell culture and bioprinting.

Dr Marie Siganto AM presents Dr Christoph Meinert with the 2018 Siganto Foundation Medal

Award-winning IFE researchers

Award	Researcher/Team	Contribution
Royal Australian Chemical Institute Graeme Batley Medal for excellence in analytical chemistry	CARF Director, Professor Stephen Blanksby	Peer recognition for novel work in mass spectrometry technology and its application in analytical chemistry
Fellow of the Australian Academy of Science	Distinguished Professor Kerrie Mengersen	Internationally recognised and significant contributions in the field of Bayesian statistics theory, methodology and computation and its application to substantive problems
Bioenergy Australia Conference	QUT Industrial biotechnology, bioproducts and biorefining team	Recognising contribution to bioenergy research and the development of the sector in Australia over recent decades
Australian Institute of Policy and Science Queensland Young Tall Poppy Award	Dr James Blinco	Acknowledging work in polymer and organic chemistry, and recognise and celebrate Australian intellectual and scientific excellence
Fostering International Research and Development Award from Bharatiya Sugar	Professor Sagadevan Mundree	Recognising outstanding leadership and contribution to the Australian and South African sugar industry

Professor Ian O'Hara (R) congratulates Dr James Blinco (L) on receiving the Australian Institute of Policy and Science Queensland Young Tall Poppy Award

Queensland Senior Australian of the Year: Distinguished Professor James Dale AO
In November, QUT scientist and humanitarian, Distinguished Professor James Dale AO was honoured as 2019 Queensland Senior Australian of the Year. Professor Dale has led significant research in agricultural biotechnology and is founder of Australia's first molecular farming company, Farmacule Bioindustries. His ground-breaking work includes modifying bananas to treat Vitamin A deficiency in developing countries and creating strains of disease-resistant bananas to protect Queensland's banana crops.

Distinguished Professor James Dale

People

The IFE team catalyses, supports, conducts and profiles research and innovation aligned with IFE's research themes, enabling platforms and research infrastructure.

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.

Humans of IFE: Melissa Burton

"IFE is critical to QUT's ambitious research agenda, making it an exciting time to be working both in the institute and university. As Institute Manager, I get to work on a daily basis with a range of talented people both across the institute's research program and its facilities."

Melissa Burton, Institute Manager, IFE

People

2018 highlights

- **New IFE senior leaders** – IFE made several appointments to leadership roles in 2018:
  - Acting Executive Director – Professor Ian O'Hara
  - Deputy Executive Director – Professor Roger Hellens
  - Leader, Transforming Innovation Systems Enabling Platform – Professor Rachel Parker
  - Leader, Growing the Global Bioeconomy Research Theme – Associate Professor Robert Speight
  - Leader, IntelliSensing Enabling Platform – Dr Erin Peterson
  - Manager, Central Analytical Research Facility – David Harris

- **IFE Domain Leaders** – IFE established a new cohort of transdisciplinary research leaders in 2018. After identifying three or four primary domains of research within each of IFE's four research themes and three enabling platforms, IFE appointed 23 Domain Leaders. The Domain Leader roles are intended to develop research projects that help IFE deliver on its Strategic Actions, help QUT deliver on its Blueprint and help our end users make an impact in the real world. The Domain Leaders include academics from all six of QUT's faculties, so they will help IFE consolidate and expand its networks within and across faculties.

- **Industry Mentoring Scheme** – IFE initiated a scheme to give researchers one-on-one time with senior industry figures working in fields relevant to their research. The first mentoring sessions were held on 31 August, when John Puttick, Chair of the IFE Advisory Committee, met with three IFE Domain Leaders. More mentoring sessions were held with the Hon. Trish White (National President and Chair, Engineers Australia) and with Ronni Kahn (CEO and Founder of OzHarvest) when they visited QUT to deliver Grand Challenge Lectures.

- **IFE Research Project Lifecycle Review** – As well as participating in the QUT Research Support Services Review this year, IFE started a project to map the lifecycle of an IFE research project from a researcher's perspective and align the IFE Directorate's services with the various lifecycle stages. The goal of the project is to streamline the processes and interactions, minimise the contact points and pain points for researchers, and ultimately provide smooth, seamless administrative support for IFE-managed research projects.

- **Research infrastructure business improvements** – IFE implemented a program of business improvement activities across its Research Infrastructure portfolio, designed to ensure the most effective and efficient operation of its research facilities and capabilities to support QUT's research and industry partnerships. Key examples of this in 2018 include the review and redesign of client orientation and induction processes for both the Central Analytical Research Facility and the Banyo Pilot Plant Precinct. These changes have improved the client experience by streamlining the flow from first contact through to commencing work in the research infrastructure, reduced the administrative burden for IFE staff and ensured all users undergo appropriate safety induction and work-specific training prior to commencing work.

- **QUT Research Linkage Lunches** – In September 2018, IFE and the Science and Engineering Faculty commenced a series of monthly Research Linkage Lunches to provide researchers with an opportunity to discuss their Australian Research Council Linkage and other grant proposals, learn from other researchers, and obtain advice and feedback on how to submit applications.

Equity, diversity and inclusion

Aboriginal and Torres Strait Islander people

QUT is committed to achieving sustainable reconciliation between Aboriginal and Torres Strait Islander people and non-Indigenous Australians. Educational institutions have a particular responsibility to redress Indigenous disadvantage and overcome prejudice against Indigenous peoples through their teaching, research and community service. IFE supports and espouses the university's commitment to reconciliation in various ways.

Consistent with QUT's goal of increasing employment and development opportunities for Indigenous people, IFE created a new role at our Banyo Pilot Plant Precinct in 2018. This Engineering Mechanical Trade (Machining) Apprenticeship is an important step in building meaningful and sustainable employment opportunities for Indigenous people at IFE and QUT. Zeph Kadel, who started in the role in October 2018, has been employed on a four-year contract to enable full completion of his apprenticeship and associated training.

IFE has committed $30,000 to a scoping project about the native bee population of North Stradbroke Island. The project will involve researchers from QUT's Science and Engineering Faculty and Faculty of Health and a researcher from the community of North Stradbroke Island. The initial phase will scope a larger research project that examines whether the hives, honey, health and behaviour of native bees reflect the overall health of their environment, how we can create an environment that supports the bee population and whether the bees' honey have any unique medicinal properties.

The Institute's Centre for Tropical Crops and Biocommodities is engaged with the Pudakul Aboriginal Community in the Northern Territory through an R&D project on native rice that CTCB is involved in with colleagues from Charles Darwin University. This project has provided opportunities for capacity building activities with Indigenous students, particularly in terms of mechanisation of local agricultural activities.

IFE also strives to raise awareness of Indigenous culture, experiences and perspectives through our events program. All IFE public events, such as our Grand Challenge Lectures, and major internal gatherings, such as our all-staff Town Hall Meetings, begin with an Acknowledgement of the Traditional Owners.

One of the 2018 Grand Challenge Lectures was delivered by Indigenous man and QUT alumnus Wayne Denning, managing director of creative agency Carbon Creative, on the topic 'Provoking Intergenerational Change: Empowering a Generation to Close their Own Gap'.

Indigenous high school students seeing life through the microscope during a visit to IFE's Central Analytical Research Facility

Gender equity

In 2018, QUT successfully applied for a Bronze Award from the SAGE Athena SWAN program, which seeks to increase gender equity and diversity in the STEMM higher education and research sector. SAGE (Science in Australia Gender Equity) was established by the Australian Academy of Science and the Australian Academy of Technology and Engineering to pilot the UK's Athena SWAN (Scientific Women's Academic Network) program in Australia.

Part of QUT's SAGE Athena SWAN accreditation application was an Action Plan covering QUT-wide and STEMM-specific initiatives, some new and some established, to support gender equity and diversity in the recruitment, progress and retention of staff in STEMM faculties and institutes. IFE developed a local action plan in 2018 outlining what the institute will do to help QUT implement its SAGE Athena SWAN Action Plan.

The actions in the QUT and IFE plans fall into the broad themes of policy, practice and organisational culture; recruitment; career development and retention, work-life balance and career breaks; governance, monitoring and future planning; and information and data systems. Over the course of 2019, IFE will start implementing and continue refining its gender equity action plan.

Governance

IFE's Governance Committee, Executive Team, Research Leadership Working Group, and Health, Safety and Environment Committee oversee the direction, performance, policies and safety of IFE.

IFE Governance and Management Bodies

IFE Portfolio

| **IFE Advisory Committee** Industry, government and academic leaders | **IFE Governance Committee** Senior QUT leaders, including DVCs and Deans | **IFE Executive Team** Senior IFE leaders |

Transdisciplinary research & innovation

IFE Research Leadership Working Group
IFE's research theme and enabling platform leaders and allied roles

CTCB Governance Committee
Senior QUT leaders, including several DVCs and Deans

IFE Research Theme and Enabling Platform Leadership Teams
Academic representatives from QUT's six faculties

Cross-organisation research infrastructure

IFE Research Infrastructure Advisory Group
Senior QUT leaders and infrastructure focus area leaders (academics)

IFE Research Infrastructure Leaders Working Group
IFE infrastructure and facility managers and allied roles

IFE Facility Steering Groups
Steering groups for Digital Observatory (established) and other IFE facilities (in development)

Transdisciplinary research culture & sustainability

IFE Health, Safety and Environment (HSE) Committee
IFE HSE advisors, HSE representatives and other HSE-related roles

IFE Directorate Team Leaders Working Group
Managers of the IFE Directorate's support teams

IFE Advisory Committee

Established in 2017, the IFE Advisory Committee advises on research priorities and infrastructure development, on partnership, profiling and fundraising opportunities, and on transdisciplinary research culture and practice. The committee held its second meeting on 12 June 2018, and consisted of the following representatives from Australia, Europe and the US:

The IFE Advisory Committee comprises national and international industry, government and academic leaders

- 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 Ian O'Hara – Acting 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 2018, 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 Ian O'Hara – Acting Executive Director, IFE
- Professor Roger Hellens – Deputy 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 2018 included:

- Professor Ian O'Hara – Acting Executive Director as Chair
- Professor Roger Hellens, Deputy Executive Director
- Professor Peter Corke, Director, Australian Centre for Robotic Vision
- 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

During 2018, the IFE Health, Safety and Environment (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. The HSE Committee reviews safety concerns, workplace injuries, hazards and near misses. In 2018, the committee investigated the following reports:

- six workplace injuries or illnesses – caused by contact with objects including sharps, contact with chemicals, falls and muscular stress
- 19 safety issues – caused by biological and chemical exposure, work environment issues including faulty equipment and ergonomics, and vehicle incidents (work journeys)
- one environmental issue – related to accidental spill of water from a chiller into the stormwater drain
- one WorkCover claim.

Appropriate controls and procedures were developed to mitigate against potential risks.

During 2018, the Queensland Crime and Corruption Commission audited how QUT manages security risks associated with certain chemicals. Several IFE laboratory facilities were inspected. QUT and IFE's policies, guidelines and procedures; education and training; and processes around the use of high-risk chemicals indicated satisfactory management in these areas.

A new laboratory user orientation process for students and staff accessing IFE's Central Analytical Research Facility laboratories was launched in March 2018. The new process incorporates a standard agreement requiring users to follow relevant QUT HSE policies and procedures, risk assessments and standard operating procedures and complete mandatory QUT evacuation, HSE induction and lab safety training. Supervisors must also acknowledge their responsibilities as part of the standard agreement.

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 28 August 2018, the UAEC review panel visited IFE's Aquaculture Facility located at the Banyo Pilot Plant to assess the facility, aquaria equipment and records of activities involving animals. The facility at that time was being used to house swordtail fish, a popular aquarium species which have become a pest in Queensland watercourses. The panel found no issues with the facility tanks, lighting, temperature, noise, food and water quality for the fish. The fish were found to be healthy and provided with adequate environmental enrichment. Recommendations on processes included display of regulatory documentation, labelling of tanks and maintenance in the facility of more detailed records of activities involving fish.

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 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.

Sustainability

IFE is committed to being sustainable in its operations and service delivery. IFE operations currently include sustainability measures such as recycling, reducing or removing single-use plastic serveware used for event catering, collection of food waste, ordering of sustainable office supplies and the use of keep cups and totes as promotional merchandise. IFE is headquartered in QUT's Science and Engineering Centre, which has achieved a 5-star Design Education V1 Certified rating from the Green Building Council of Australia.

Financial report

The table below provides a summary of transactions on IFE-related accounts for the period 2016–2018. 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	2016 $ '000s	2017 $ '000s	2018 $ '000s
Research			
Competitive Grants+	6 309	9 658	12 475
University Distributions	1 901	3 765	6 961
Commercial	5 690	7 548	7 812
Sub-total	13 900	20 970	27 248
Operations			
University Distributions	14 004	14 768	15 531
Other	658	658	543
Sub-total	14 662	15 426	16 074
TOTAL REVENUE	**28 562**	**36 396**	**43 323**

Expenses	$'000s	$'000s	$'000s
Research			
Employee Costs	(8 130)	(9 342)	(10 262)
Non-Employee Costs	(5 384)	(5 062)	(6 994)
Sub-total	(13 514)	(14 403)	(17 257)
Operations			
Employee Costs	(14 678)	(15 028)	(16 414)
Non-Employee Costs	(5 537)	(4 415)	(4 478)
Sub-total	(20 215)	(19 443)	(20 892)
TOTAL EXPENDITURE	**(33 729)**	**(33 847)**	**(38 149)**
Opening Retained Funds	13 408	8 497	11 260
Profit/(Loss)	(5 167)	2 549	5 174
Retained Funds Transfer	(730)	(4)	361
Capital Acquisitions++	(494)	(1 202)	(1 545)
Depreciation	1 480	1 420	1 282
Closing Retained Funds	**8 497**	**11 260**	**16 533**

+ IFE Managed Projects

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