

ANNUAL REPORT 2016



ABOUT US

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 students from across the fields of science, engineering, law, business, creative industries, health and education collaborate at IFE on large-scale projects relating to our natural, built and digital environments.

Our mission

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

Our vision

To be renowned as a catalyst for:

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

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2016 HIGHLIGHTS

Research and innovation



AGRICULTURE

- Successful field trials of biofortified bananas (page 12)
- Irrigation app for vegetable growers (page 24)
- Building bioproduct opportunities for Australian producers (page 11)
- Nitrogen management strategies for mango farmers (page 15)
- Data mining to discern the future of Australian agriculture (page 27)



ENVIRONMENT

- Simple farm solution to nitrogen pollution of waterways (page 14)
- New fabric that could clean up oil spills (page 29)
- Tracking koala populations using drones with thermal cameras (page 23)



ENERGY

- Superconductor technology that could transform transportation (page 30)
- Using maths to map innovation in the energy sector (page 26)
- Helping Queenslanders to manage and reduce their electricity use (page 17)



SERVICE DELIVERY

- Proactive and personalised government services on digital platforms (page 20)
- Designing senior living services that support active ageing (page 18)
- Linking diagnostic toilets to expert medical advice (page 21)



Inspiring and nurturing research impact

✓ **Catapult funding** program launched – **88** applications, **12** projects under way

✓ **3,000** attendees at **13** Grand Challenge Lectures and **32** Distinguished Visitor Lectures

✓ **8,796** website visitors

✓ **1,000** Twitter followers

✓ **Widespread** local, national and international media coverage

✓ **Popular** forums, symposiums, workshops and competitions



New leaders appointed

- Executive Director – Professor Bronwyn Harch
- Director, Research Infrastructure – Sach Jayasinghe
- Institute Manager – Melissa Burton
- Research Theme Leader, Embracing the Digital Age – Professor Marek Kowalkiewicz
- Enabling Platform Leader, Manufacturing with Advanced Materials – Associate Professor Anthony O'Mullane



Award winners

- Statistical Society of Australia Pitman Medal - Distinguished Professor Kerrie Mengersen
- 2016 McCullough Life Sciences Queensland Industry Excellence Award - Professor Sagadevan Mundree
- Women In Technology Infotech Outstanding Achievement Award - Associate Professor Dr Richi Nayak
- Google Impact Challenge People's Choice Winner - Dr Matthew Dunbabin and Dr Feras Dayoub and Great Barrier Reef Foundation

MESSAGE FROM THE EXECUTIVE DIRECTOR



I had the great honour of being appointed Executive Director of Institute for Future Environments (IFE) in July 2016. My predecessor, Professor Ian Mackinnon, had led IFE since its inception in 2011, overseeing the establishment of IFE's workforce, infrastructure and research agenda. Ian has been one of the driving forces behind the shift to a transdisciplinary research culture at QUT and I am very grateful to him for his ongoing advice and support.

Our mission at IFE remains the same – to generate knowledge, technology and practices that make our world more sustainable, secure and resilient – but over the course of 2016 we reviewed the Institute's strategy, core functions and structure. This resulted in several changes, including the establishment of new teams dedicated to project delivery and research administration. By and large, though, the review confirmed that the structure of the Institute reflects its core functions, which in turn reflect the Institute's mission and purpose.

We also developed the Institute's 2017–2019 Strategic Plan, which sets out our strategic actions and activities for the next three years, under three Key Priorities:

- Transdisciplinary research and innovation
- Cross-organisation research infrastructure
- Transdisciplinary research culture and sustainability.

Moreover, in order to evaluate the impact of our research on the real world, we developed impact measures for each of IFE's research themes and enabling platforms. These measures, which we will start tracking in 2017, are listed on the theme and platform overview pages in this report.

You will find many examples in this report of how IFE, in partnership with industry, government and the community, is conducting high-impact research. Professor Marek Kowalkiewicz worked with the Queensland Government on developing more proactive and personalised public services; the result was a suite of new online portals and tools, including the Queensland Business Grants and Assistance Finder (see page 20). Professor Laurie Buys, leader of the Senior Living Innovation research program, worked with RSL Care on redesigning their retirement village at Caboolture (see page 18). At our Banyo Pilot Plant Precinct, researchers started testing new high-temperature

superconductor technologies, as part of a research alliance with Siemens and the Australian Government's Defence Science and Technology Group (see page 30).

We had many other success stories in 2016. Drs Matthew Dunbabin and Feras Dayoub and Professor Peter Corke, in partnership with Great Barrier Reef Foundation, won the \$750,000 People's Choice Award at the 2016 Google Impact Challenge. The research team plan to design, build and trial the RangerBot, an autonomous reef monitoring and protection submersible (see pages 40 and 43).

Professor Ian O'Hara started a major new Biorefineries for Profit research project, utilising our Mackay Renewable Biocommodities Pilot Plant, and was appointed the inaugural Biofutures Industry Envoy by the Queensland Government (see page 49). David Poxon, winner of the pitching competition at our entrepreneurial masterclass Übercamp in 2015, launched his wi-fi sharing business Velvet in September 2016 (see page 40).

IFE also supports researchers working on promising new transdisciplinary ideas. In 2016, we established the Catapult program to provide seed funding for short-term projects aligned with IFE's research themes and enabling platforms (see page 8). Catapult helps form new transdisciplinary teams to develop and refine prototypes and practices and gather evidence that they will be effective if implemented or deployed on a large scale.

IFE welcomed two new research leaders to the team in 2016: Professor Marek Kowalkiewicz, PwC Chair in Digital Economy at QUT, became the Leader of our Embracing the Digital Age Research Theme and Associate Professor Anthony O'Mullane was appointed Leader of our Manufacturing with Advanced Materials Enabling Platform. Other major appointments were our new Institute Manager, Melissa Burton, and Director of Research Infrastructure, Sach Jayasinghe (see page 48).

Finally, I would like to thank all IFE's participants (the academics from across QUT who have worked on IFE projects and used IFE facilities), staff (who support the business of undertaking transdisciplinary research) and end-user partners for their passion and dedication in working with us towards a more sustainable, secure and resilient world.

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

Professor Bronwyn Harch
IFE Executive Director

RESEARCH AND INNOVATION

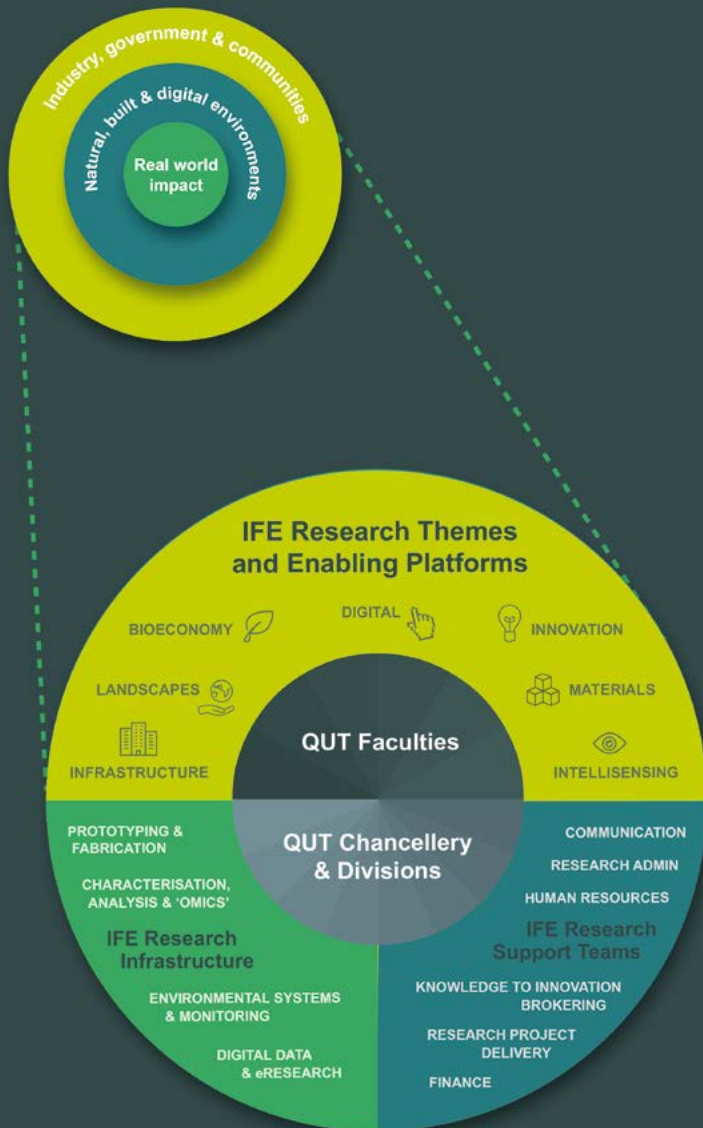
Our researchers work in transdisciplinary teams, in partnership with industry, government and non-profit organisations, on projects to improve our natural, built and digital environments.



Our research agenda

Catalysing Innovation

Our researchers study our natural, built and digital environments and find ways to make them more sustainable, secure and resilient. IFE builds transdisciplinary teams of researchers from QUT's faculties, supported by first-class research facilities and research support professionals.



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

QUT aspires to be a global leader in delivering research solutions to real world problems. QUT's six faculties – Science and Engineering, Creative Industries, Business, Law, Education and Health – have broad expertise and research capabilities across the natural and social sciences. The university is striving to build its reputation as an excellent research institution by conducting high-impact research that is:

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

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

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

IFE addresses social and economic challenges in a range of key sectors, including agriculture, mining, environmental management, manufacturing, services, and information communication and technology.

We collaborate with partners at every stage of the innovation process — from identifying problems and questions to developing new technologies, techniques and ideas through to final application and/or commercialisation.

IFE's research program comprises four research themes and three enabling platforms. Each research theme and enabling platform has an academic theme leader, a leadership team with broad relevant expertise, dedicated research support staff and a network of research academics from within the faculties.

Research themes

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

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

The scope and activities of the four research themes are covered in more details on pages 10 to 21.

Enabling platforms

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

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

The scope and activities of the three enabling platforms are covered in more details on pages 22 to 30.

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

Allied research centres

During 2016, IFE supported a number of local and national research centres that work in areas aligned with our research themes and enabling platforms:

- **Centre for Tropical Crops and Biocommodities (CTCB)** – plant biotechnology, process engineering, industrial chemistry and commercialisation (aligned to the Growing the Global Bioeconomy theme).
- **Australian Research Council Centre of Excellence for Robotic Vision (ACRV)** – creating robots that can visually sense and understand complex, unstructured environments (aligned to the IntelliSensing enabling platform)
- **Australian Research Council Centre of Excellence for Mathematical & Statistical Frontiers (ACEMS)** – advanced mathematics, statistics, analytics, machine learning data and modelling (aligned to the IntelliSensing enabling platform)
- **Australian Research Centre for Aerospace Automation (ARCAA)** – unmanned aerial vehicles, aviation automation, on-board sensor systems (aligned to the IntelliSensing enabling platform)
- **Australia-China Centre for Air Quality Science and Management (ACC AQSM)** – developing new technologies and techniques to better monitor, prevent and mitigate air pollution (aligned to the Managing for Resilient Landscapes theme).

Research infrastructure

IFE hosts state-of-the-art research infrastructure capabilities, encompassing expertise in digital data and e-research; characterisation, analysis and 'omics'; prototyping and fabrication; and environmental systems and monitoring. Our facilities play a vital role in supporting transdisciplinary research on a scale beyond the reach of individual research groups or disciplines. The technical staff in our facilities work closely with researchers and clients to identify and implement the best solutions to their problems.

Science and Engineering Centre

Home to the IFE Directorate, CARF, ViseR, The Cube and project rooms, as well as several allied organisations including METS Ignited Growth Centre and the Queensland nodes of the Australian Research Council Centre for Excellence for Mathematical and Statistical Frontiers (ACEMS) and the CRC for Spatial Information (CRC SI)



Central Analytical Research Facility (CARF)

Purpose-built labs for electron and light microscopy, analytical and environmental chemistry, molecular genetics, proteomics, mass spectrometry, X-ray and neutron diffraction, and physical and mechanical properties



Visualisation and eResearch (ViseR)

An expert team using cutting-edge software platforms and AV and IT equipment, including The Cube, to develop innovative ways of modelling and visualising complex information for QUT, industry and government partners



Samford Ecological Research Facility (SERF)

A 51 hectare peri-urban field station used for ecosystem research, environmental monitoring (soil, water, air and sound), and animal and plant population and behaviour studies



Banyo Pilot Plant Precinct

A general purpose facility for large-scale structural, mechanical, electrical and water engineering and aquaculture research, as well as product testing and validation and sample processing



Mackay Renewable Biocommodities Pilot Plant

A unique research facility, based on the site of an operating sugar factory, that develops technology and processes to convert biomass into biofuels and other bioproducts

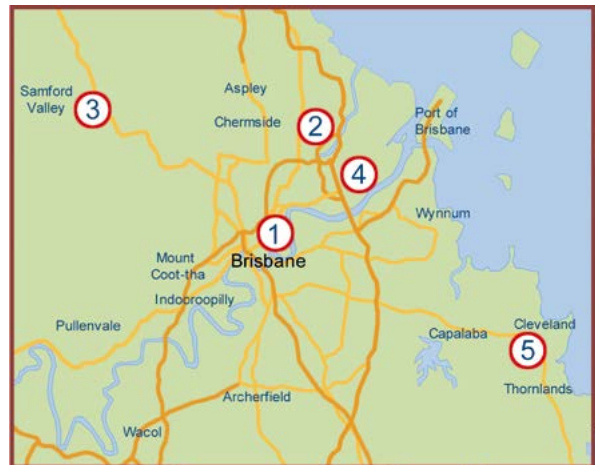


Da Vinci Precinct

An aerospace automation facility that includes an aircraft simulation and testing laboratory, an avionics development area, an indoor flying area, a general workshop and an office area



IFE headquarters are located in the Science and Engineering Centre at QUT's Gardens Point campus, but our research facilities are spread around Brisbane and Queensland, as shown in the maps below.



KEY

- 1 Gardens Point Campus (Science and Engineering Centre, Central Analytical Research Facility, The Cube)
- 2 Banyo Pilot Plant Precinct
- 3 Samford Ecological Research Facility
- 4 Da Vinci Precinct
- 5 Redlands Research Station
- 6 Mackay Renewable Biocommodities Pilot Plant
- Field site



Queensland Crop Development Facility

Situated at the Redlands Research Facility, this 22 hectare tropical, subtropical and molecular farming research facility, owned by the Queensland Government and managed by the Department of Agriculture and Fisheries, includes five glasshouses and field plots for crop trials



Catapult: new funding to launch transdisciplinary research

In February 2016, IFE launched a new seed funding program to support research by QUT academic staff that is aligned to the Institute’s research themes and enabling platforms. The Catapult program is designed to enhance the technology readiness levels of promising transdisciplinary research ideas, ensuring that QUT research is able to move along the continuum from creative discovery and successful application through to adoption by industry or government. The funding is for projects that can be completed within 12 months, with a maximum amount of \$100,000 per application.

During 2016, three Catapult funding rounds were held, attracting a total of 88 applications and resulting in funding approval for 12 research projects.

Project title	IFE research theme or enabling platform	Project leader	Participating faculties, centres and facilities
Monitoring and reducing human impacts on water quality entering the Great Barrier Reef through best practice urban planning and management	Managing for Resilient Landscapes	Dr Karen Vella	Science & Engineering Faculty
Small peptides as a replacement for synthetic pesticides in agriculture	Growing the Global Bioeconomy	Dr Peter Prentis	Science & Engineering Faculty; Central Analytical Research Facility
Veganism as a vehicle to grow the global bioeconomy	Growing the Global Bioeconomy	Dr Ozgur Dedehayir	Business School; Creative Industries Faculty
Future fruit	Growing the Global Bioeconomy	Prof Roger Hellens	Science & Engineering Faculty; Creative Industries Faculty
Investigating the entrepreneurial success factors of innovative hardware ventures like Fitbit, Oculus and Nest	Embracing the Digital Age	Dr Frederik von Briel	Science & Engineering Faculty; Business School
Regulation of sugar cane farming in the Great Barrier Reef catchment area: a cap and trade framework	Managing for Resilient Landscapes	Dr Felicity Deane	Law Faculty; Science & Engineering Faculty; Business School

Project title	IFE research theme or enabling platform	Project leader	Participating faculties, centres and facilities
Optimising cognitive inputs and data analytics for decision support	IntelliSensing	Dr Kate Devitt	Law Faculty; Creative Industries Faculty; Science & Engineering Faculty
Investigating environmental conditions and end-user experience at the Lady Cilento Children's Hospital's 'healing gardens'	Infrastructure for Sustainable Communities	Associate Professor Cheryl Desha	Science & Engineering Faculty; Creative Industries Faculty
Bio-hydrogen production from microbial electrolysis cells	Manufacturing with Advanced Materials	Associate Professor Anthony O'Mullane	Science & Engineering Faculty; Centre for Tropical Crops & Biocommodities; Central Analytical Research Facility
A generic IntelliSensing software platform to support data-enabled decision making	IntelliSensing	Dr Erin Peterson	Science & Engineering Faculty; Visualisation and eResearch (ViseR) team
Integrated lighting design for older adults' homes	Infrastructure for Sustainable Communities	Dr Veronica Garcia Hansen	Creative Industries Faculty; Science & Engineering Faculty
Steps towards a legal framework for high levels of autonomy in field robotics	IntelliSensing	Professor Belinda Bennett	Law Faculty; Science & Engineering Faculty; Health Faculty

Research theme: Growing the Global Bioeconomy

Leadership	
THEME LEADER	<ul style="list-style-type: none"> • Professor Roger Hellens (January to June 2016) • Associate Professor Robert Speight (July to December 2016 – acting leader)
LEADERSHIP TEAM	<ul style="list-style-type: none"> • Faculty of Science and Engineering Faculty: Dr Peter Prentis; Dr Melody de Laat; Dr Pawel Sadowski; Dr Kevin Dudley; Dr Matthew Phillips • Faculty of Business: Dr Judy Matthews • qutbluebox: Callum Hickey • Knowledge to Innovation Broker: Dr Susan Theiss

Real world context	
KEY TRENDS	<p>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. Around a third of all food produced for human consumption is lost or wasted, yet little of this waste is converted to valuable byproducts. Society increasingly expects agricultural operations to be environmentally friendly and sustainable, but many people are still resistant to genetically modified agricultural products</p>
GRAND CHALLENGES	<ul style="list-style-type: none"> • 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	<p>We are investigating how to:</p> <ul style="list-style-type: none"> • 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	<p>Our research is designed to drive the following changes in the real world:</p> <ul style="list-style-type: none"> • more profitable bioeconomy industries • more sustainable bioeconomy inputs • increased health benefits from food.
MEASURES	<p>We are tracking the impact of our research using the following lead indicators:</p> <ul style="list-style-type: none"> • research funding for new cultivar/technology pair development • number of genetically modified or advanced breeding products QUT has moved up the technology readiness scale • number of bioprocesses run at pilot scale per year (moving up the technology readiness scale or validation of commercial processes in Australia).

Case study: Accelerating into the biofuture

Project or program title	Biorefineries for Profit
Research theme or enabling platform	Growing the Global Bioeconomy/Centre for Tropical Crops and Biocommodities
QUT project team	Professor Ian O'Hara; Dr Mark Harrison, A/Prof Robert Speight, Prof William Doherty, A/Prof Philip Hobson, Dr Stephen Cox
Partner organisations	Sugar Research Australia; Australian Government Department of Agriculture and Water Resources through the Rural Research and Development for Profit Program; Queensland Government Department of Agriculture and Fisheries; Cotton Research and Development Corporation; Forest & Wood Products Australia; Australian Pork Ltd; Southern Oil Refining; NSW Department of Primary Industries
Timeline	2016–2019

Why it matters

Australian agriculture must continually adapt and innovate to remain competitive in an environment of rising production and compliance costs, climate variability, pests and disease, and changing global patterns of production and consumption. Biorefining generates valuable bioproducts from agricultural primary and waste by-products. This increases profitability, productivity and sustainability for primary producers while reducing environmental impacts.

How the IFE is making an impact

The emerging global bioeconomy is creating new market opportunities for agricultural producers while underpinning the viability of existing crop products and supply chains. Working with Sugar Research Australia, our researchers are building opportunities to help Australian agricultural producers to create a profitable future.

The Biorefineries for Profit research project is developing technologies to convert Australian agricultural and forestry feedstocks into new value-added animal feeds, advanced fuels and chemicals. The project is also building value-chain knowledge and the human and organisational capacity to identify and develop future biorefinery opportunities for Australian agriculture.

The project seeks to establish profitable bioproduct opportunities for Australian primary producers and other participants in the sugar industry as well as the cotton, forestry and animal feed industries. It also aims to help those same industries to reduce input costs by, for example, using less expensive feeds and fuels. Developing technologies, knowledge and capacity to increase revenue from existing agricultural, forestry and animal industries with rapid paths to market will deliver increased productivity and profitability for primary producers. The project commenced in early 2016 and now engages over 20 researchers across seven activities.

Led by Professor Ian O'Hara, this project is supported by funding from the Australian Government Department of Agriculture and Water Resources as part of its Rural Research and Development for Profit programme.

Research infrastructure for the real world

IFE's Mackay Renewable Biocommodities Pilot Plant, based on the site of an operating sugar mill, is a unique research and development facility that converts biomass into biofuels, green chemicals and other bioproducts. Access to the pilot plant has advanced research in the Biorefineries for Profit project with the project already demonstrating the ability to transform sugarcane biomass at scale for feeds and fuels.



Professor Ian O'Hara at IFE's Mackay Renewable Biocommodities Pilot Plant

“Professor O'Hara has a national and international reputation in both industry and the research sector. He understands how our agricultural and waste industries run and how to unlock more value from them using industrial biotech. His knowledge and networks will be instrumental in attracting and securing domestic and international investment in Queensland's biofutures industry.” – Queensland State Development Minister Dr Anthony Lynham

Case study: Fighting malnutrition with boosted bananas

Project or program title	Micronutrient Biofortified Cooking Bananas for East Africa
Research theme or enabling platform	Growing the Global Bioeconomy/Centre for Tropical Crops and Biocommodities
QUT project team	Distinguished Professor James Dale; Professor Robert Harding; Dr Jean-Yves Paul; Dr Ben Dugdale; Dr Anthony James
Partner organisations	Bill & Melinda Gates Foundation; National Agricultural Research Organisation (Uganda); UK Department for International Development; International Institute for Tropical Agriculture; Malawi Department of Agricultural Research Services
Timeline	Ongoing

Why it matters

In developing countries, more than a million children under the age of five die or become permanently blind every year as a result of vitamin A deficiency. One promising solution to this major public health problem is biofortification, the practice of increasing the levels of particular vitamins or minerals in staple food crops to deliver essential micronutrients as part of a community's daily diet. In Uganda, cooking bananas (or matooke) are a staple food: average consumption exceeds 500g per person per day. Consequently, biofortification of bananas has great potential to alleviate vitamin A deficiency as well as iron deficiency, both extremely common in Uganda and other countries in East Africa.

How IFE is making an impact

In 2005, the Bill & Melinda Gates Foundation funded QUT, in collaboration with the National Agricultural Research Organisation of Uganda, to develop genetically modified East African Highland bananas with elevated pro-vitamin A and iron levels. A team of researchers in QUT's Centre for Tropical Crops and Biocommodities (CTCB), led by Distinguished Professor James Dale, has developed technologies to increase the nutritional value and the disease resistance of bananas.

The research team has moved a single gene from a banana called Asupina, which is low-yielding but naturally high in pro-vitamin A, into both Cavendish and East African Highland bananas. Some of the resulting bananas have more than 20 times more pro-vitamin A than the original banana.

“Our primary goal is to help [Professor] Dale develop new types of banana that are more nutritious—specifically, much richer in Vitamin A and Iron that the body can absorb. This is important because the diets of millions of people in Africa are deficient in both of these vital nutrients.” – Bill Gates (www.gatesnotes.com, 2012)



QUT Distinguished Professor James Dale and Ugandan PhD researcher Stephen Buah with the pro-vitamin A-enriched banana developed at QUT

The project has progressed to field trials in Uganda, with very positive results to date: the trial bananas have shown pro-Vitamin A levels well above the targeted levels. The field trials will continue into 2017 and 2018.

The long-term goal of the project is to release the biofortified banana plant to Ugandan farmers in 2021. It has the potential to be the first GM biofortified crop to be released anywhere in the world as well as the first GM bananas released. Importantly, the East African Highland bananas grown in Uganda are being generated in Uganda for local farmers and their families. Uganda's National Agricultural Research Organisation is applying the technologies developed by the research team at QUT.

Banana production worldwide is increasingly limited by disease, including viral diseases such as bunchy top and fungal diseases such as Fusarium wilt tropical race 4 (TR4). In another project funded by the Bill & Melinda Gates Foundation, QUT researchers have developed Cavendish bananas with resistance to bunchy top. Cavendish banana production in Malawi has been devastated by bunchy top and these modified bananas should help resurrect this important cash crop for Malawi's farmers. In July 2016, a field trial of these bananas started in Malawi. The first results from this initial trial will be available in mid-2017 with the trial continuing through to the end of 2018.

Research theme: Managing for Resilient Landscapes

Leadership

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

Real world context

KEY TRENDS	Landscapes and ecosystems around the world are under enormous pressure from the growing human population, 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	<ul style="list-style-type: none"> • Reducing greenhouse gas emissions and adapting to climate change • Sustainably producing 50% 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	<p>Our research is designed to drive the following changes in the real world:</p> <ul style="list-style-type: none"> • improved resilience and condition of natural and managed ecosystems • increased resource use efficiency, productivity and profitability • increased ecosystem goods and services.
FOCUSES	<p>We are investigating how to:</p> <ul style="list-style-type: none"> • 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.
MEASURES	<p>We are tracking the impact of our research using the following lead indicators:</p> <ul style="list-style-type: none"> • Participation in the environmental planning community • Best Management Practices (BMPs) developed by QUT and promoted by industry • Number and value of externally funded projects on valuation of ecosystem goods and services.

Case study: On-farm bioreactors for cleaner waterways

Project or program title	Bioreactors for reducing nitrogen pollution of waterways
Research theme or enabling platform	Managing for Resilient Landscapes
QUT project team	Professor Peter Grace, Dr Lucy Reading, Mr Christian Brunk, Mr Fabio Manca
Partner organisations	Queensland Department of Agriculture and Fisheries, University of Waikato (New Zealand)
Timeline	2016 – ongoing

Why it matters

Nitrogen pollution from agriculture is the single biggest threat to the healthy waterways of Queensland. Bioreactors are a low-cost, simple, farm-friendly technology to reduce the run-off and leaching of dissolved inorganic nitrogen (DIN) from Queensland farms to aquatic environments such as the Great Barrier Reef lagoon and the Pumicestone Passage in South East Queensland.

Bioreactors are shallow flooded trenches or beds filled with degradable carbonaceous material. They intercept agricultural runoff and underground flows before they enter the waterways which flow into marine environments. Through a natural microbial process called denitrification, bioreactors convert the reactive DIN in the water to harmless di-nitrogen.

Bioreactors can easily be constructed by growers using existing equipment and filled with organic mill waste such as bagasse or excess sugarcane trash. This novel solution to nitrogen pollution requires no changes to farm layout, complements best management practices and is ideally suited to the warmer temperatures of tropical and subtropical regions.

How the IFE is making an impact

In collaboration with the University of Waikato and the Queensland Department of Agriculture and Fisheries, an IFE research team is constructing and implementing bioreactors as a community-based solution for the rapid reduction in nitrogen pollution in marine environments.

This project builds on the IFE Managing for Resilient Landscapes research theme's internationally recognised expertise in fostering sustainable agriculture and soil health through improved management of the soil carbon, nitrogen and water cycles and reducing reactive nitrogen pollution from agriculture.



On-farm bioreactors

Through a combination of soil and groundwater flow studies, the project team is monitoring the fate, residence time and conversion of nitrogen fertilisers from fields to waterways to determine the optimum conditions for DIN removal in the bioreactors. A wide variety of carbonaceous materials are being tested – including organic wastes from sugarcane mills, sugarcane residues (trash) and woodchips – to identify which low-cost, biodegradable fuel sources are the most effective at removing nitrogen.

Research infrastructure for the real world

Stable isotope analysis of nitrogen and oxygen is being performed in IFE's Central Analytical Research Facility (CARF), complementing modelling and greenhouse gas emission studies using automated gas sampling chambers and gas chromatographic analysis in the field.

Case study: Increasing nitrogen use efficiency for profitable mango production

Project or program title	Increasing Nitrogen Use Efficiency in Mango Production
Research theme or enabling platform	Managing for Resilient Landscapes
QUT project team	Dr David Rowlings, Professor Peter Grace, Mr Hemant Raj Pandeya
Partner organisations	Northern Territory Department of Primary Industry, Horticulture Innovation Australia, Department of Agriculture and Water Resources, Australian Mango Industry Association
Timeline	2016 – ongoing

Why it matters

Mangoes are a significant tree crop in tropical climates of Australia with an annual value \$140M and a rapidly developing export market. Nitrogen is an essential nutrient for plant growth and development. The inputs of nitrogen fertiliser constitute a major proportion of farm production costs and greatly influence both the quantity and quality of fruit produced. The fruit and vegetable industry of Australia potentially loses up to one half of the nitrogen they apply as fertiliser which reduces profit, increases nitrogen pollution of our waterways and the atmosphere and contributes to global warming. Maximising nitrogen use efficiency is critical for the ongoing profitability of the mango industry in the Northern Territory.

How the IFE is making an impact

The IFE is partnering with growers on private mango farms to conduct research, with support from the Australian Mango Industry Association (AMIA). The mango project is part of a broader initiative bringing together four of the major intensive users of nitrogenous fertilisers (cotton, dairy, sugar and horticulture) to improve profitability by testing and adopting more efficient practices and technologies. This research is critical to fully understanding the soil chemical, physical and microbiological processes that control nitrogen supply and losses in tropical monsoonal environments and their overall relationship to soil health and plant production.

Our researchers are using an integrated approach to quantify plant nitrogen demand and cycling through the soil-plant-atmosphere system and develop nitrogen management strategies for increasing the quantity and quality of mangoes produced in tropical environments.



Field research underway at a Northern Territory mango farm

The project is part of larger Rural Research and Development for Profit (RRDFP) project funded by the federal Department of Agriculture and Water Resources. This project builds on the IFE's internationally recognised expertise in sustainable tropical agriculture and its relation to soil health and increasing nitrogen and water use efficiency.

Research infrastructure for the real world

Stable isotopes of nitrogen are analysed in the IFE's Central Analytical Research Facility (CARF) to quantify plant nitrogen uptake and losses and provide the core data for developing decision support models to optimise nitrogen demand and supply and maximise nitrogen use efficiency.

Research theme: Infrastructure for Sustainable Communities

Leadership	
THEME LEADER	<ul style="list-style-type: none"> • Professor Laurie Buys
LEADERSHIP TEAM	<ul style="list-style-type: none"> • Faculty of Creative Industries: Professor Robin Drogemuller; Professor Marcus Foth; Associate Professor Rosemary Kennedy • Faculty of Science and Engineering: Professor Gerard Ledwich; Associate Professor Geoff Walker; Dr Marc Miska; Professor Margot Brereton; Dr Vicky Liu; Dr Lyndall Bryant; Dr Tracy Washington; Dr Cheryl Desha; Dr Susan Fuller; Professor Edward Chung • Knowledge to Innovation Broker: Mr Raymond Johnson
Real world context	
KEY TRENDS	<p>The world's population is growing, ageing and urbanising. Global demand for energy, water and resources is rising while finite natural resources are declining. Communities expect that public and private infrastructure – from energy and ICT networks to transport systems and buildings – will be integrated, sustainable and tailored to community needs. New ways of designing, building and managing infrastructure are emerging in the transition from the industrial to the digital age.</p>
GRAND CHALLENGES	<ul style="list-style-type: none"> • 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	<p>Our research is designed to drive the following changes in the real world:</p> <ul style="list-style-type: none"> • Infrastructure is resilient and provides net benefits to the environment. • Infrastructure supports connected and enriched communities. • Infrastructure models are financially sustainable.
FOCUSES	<p>We are investigating how to:</p> <ul style="list-style-type: none"> • optimise the construction, performance and security of physical and virtual 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 ICT network infrastructure.
MEASURES	<p>We are tracking the impact of our research using the following lead indicators:</p> <ul style="list-style-type: none"> • number of partnerships and projects between government, industry and QUT that address environmental impacts • number of invitations for QUT to contribute to infrastructure planning processes (local, state and national) • number of QUT foresight/environmental scanning projects engaging industry/government/ community in the future of infrastructure.

Case study: Helping households to manage their electricity usage

Project or program title	Customer Responsive Risk-Managed Network Planning
Research theme or enabling platform	Instructure for Sustainable Communities
QUT project team	Professor John Bell, Professor Laurie Buys, Associate Professor Geoff Walker, Professor Robin Drogemuller, Distinguished Professor Kerrie Mengersen, Dr Desley Vine, Dr Fanny Boulaire
Partner organisations	Ergon Energy
Timeline	2015–2018

Why it matters

As the Australian population grows, the demands on our electricity network are rising. At the same time, electricity suppliers and consumers are eager to reduce the economic and environmental costs of energy usage. By lowering the peak demands on electricity systems, we can reduce both infrastructure costs and greenhouse gas emissions. Ergon Energy, which supplies electricity to homes and businesses in regional Queensland, is seeking to better understand the habits, motivations and perceptions of its residential customers, so that they can help them to manage and reduce their electricity usage.

How IFE is making an impact

A transdisciplinary team of IFE researchers, including electrical and civil engineers, statisticians and social scientists, is working with Ergon Energy to develop strategies for reducing electricity costs while still satisfying customers' needs at times of peak demand. The strategy will integrate:

- a new process for evaluating the likely responses of groups of residential customers to opportunities to reduce their peak electricity use – including new behaviours, new appliances, solar photovoltaic systems, batteries and building modifications
- rapidly deployed, temporary, mobile power generation and local energy storage systems by utilities to meet peak demand in exceptional circumstances
- modelling tools that predict a set of probable future peak demand values.

Using interviews, surveys, agent-based modelling (AGM) and electricity consumption data, the researchers are exploring customers' current and potential approaches to managing their energy use.



Participants in the workshop that analysed the electricity habits and perceptions of 16 Townsville residents

In 2016, IFE researchers conducted in-depth interviews with 16 Townsville residents to understand their beliefs and feelings in relation to their energy use. The interviewees described their household habits and their attitudes to various methods of reducing consumption.

Following the interviews, the researchers and Ergon staff analysed the interview responses. They gained deep insights into the lives and perspectives of the Townsville residents and formulated four customer personas that synthesised the most common attitudes and approaches to electricity usage. The researchers are also analysing quantitative data from past Ergon Energy surveys and trials.

In 2017 and 2018, the researchers will develop a digital model that integrates all this qualitative and quantitative data, simulates trajectories of electricity consumption and assesses the impact of different consumption patterns on the electricity network. This will ultimately enable Ergon to provide information, incentives, products and services that are tailored to the preferences of its residential customers and effective at reducing peak demands on Queensland's regional electricity system.

“Optimising the use of the electricity network provides a benefit to all Queenslanders. With growing opportunities for customers to influence their energy use to suit their lifestyle and budget, Ergon Energy wants to ensure that it can assist customers make the right choices for their individual circumstances. In this way, Ergon Energy and its customers can actively work together to best use the electricity network. Our ongoing work with QUT seeks to further deepen our knowledge of customer aspirations, needs and desire to manage their energy and how we best interact to achieve that goal.” - Robert Wilson, Ergon Energy

Case study: Designing facilities that promote active ageing

Project or program title	RSL Care Fernhill Retirement Village redevelopment
Research theme or enabling platform	Infrastructure for Sustainable Communities
QUT project team	Professor Laurie Buys, Dr Desley Vine, Cathryn Chatburn and researchers from School of Design, Business School and Science and Engineering Faculty
Partner organisations	RSL Care + RDNS; BVN
Timeline	2016 – 2017

Why it matters

Australians have one of the longest life expectancies in the world and the proportion of Australians over 65 years is projected to more than double by 2054–55. As new generations of Australians move towards older age, senior accommodation and service providers must address a number of industry challenges and respond to changing expectations, attitudes and technology. The industry has an opportunity to challenge traditional stereotypes and assumptions of ageing and develop new business models that reinvent the ageing experience and support health and wellbeing through all life stages.

How IFE is making an impact

RSL Care + RDNS, one of Australia's largest providers of services for older people, is exploring redevelopment options for its RSL Care Fernhill Retirement Village site in Caboolture, Queensland. They engaged IFE to conduct research into an integrated development concept and bring to life their vision of "active ageing" for independent living, assisted living, aged care, dementia care and community care.

IFE coordinated a series of workshops for the development of an integrated seniors living concept for the Caboolture site, drawing upon RSL Care + RDNS's guiding design principles in framing a design response that socially and physically engages residents and their families. The IFE project team included researchers with expertise in psychology, design, property, planning, physical activity, energy and construction.

“As architects and designers, BVN clearly recognises the importance of collaborations to achieve great outcomes to ensure that our designs are innovative, integrated and engaging. The outcome of this collaboration has allowed the project team to create a concept design for a progressive living environment for the ageing population which breaks the traditional institutional model.” – Kirstie Irwin, Senior Associate, BVN

Through a series of workshops, the IFE researchers collaborated with RSL Care + RDNS and BVN to conceptualise how active ageing can be innovatively realised through service provision and facility design.

Collaboratively the project team:

- defined and demonstrated an 'active ageing' design philosophy with relevant stakeholders, including possible future residents
- developed functional criteria for the concept design
- engaged in co-creating proposed concept designs with residents and their families.

The design philosophy drew upon the research into the links between people's overall wellbeing and their built and natural environments. It also considers how social participation among residents and their integration within their local communities can be enhanced, as these interactions are essential to active ageing and maintaining an active lifestyle.

The ultimate aim of the research was to provide RSL Care + RDNS with an evidence base for the development of its range of accommodation, care and support services, providing strategic clarity for future development projects. The design philosophy for the Caboolture site can be adapted and transferred to other RSL Care + RDNS sites.

“RSL Care + RDNS is committed to services that support our clients and the broader community to live healthy, active and engaged lives. New design concepts informed by changing customer needs, like those being implemented at Fernhill, Caboolture through our partnership with QUT, will help us break down traditional barriers to participation and create opportunities for our residents, whether in residential care or retirement living, to maintain and grow community connections and continue doing the things they love. We look forward to continuing our work with the QUT to create truly innovative and integrated communities that inspire our residents now and the customers of the future.” Stephen Muggleton, CEO, RSL Care + RDNS

Research theme: Embracing the Digital Age

Leaders	
THEME LEADER	<ul style="list-style-type: none"> Professor Marek Kowalkiewicz
LEADERSHIP TEAM	<ul style="list-style-type: none"> Faculty of Business: Professor Larry Neale; Professor Uwe Dulleck Faculty of Creative Industries: Dr Debra Polson; Professor Axel Bruns; Dr Markus Rittenbruch; Dr Patrik Wikstrom Faculty of Education: Mandy Lupton Faculty of Law: Professor Matthew Rimmer Faculty of Health: Professor Nicholas Graves Faculty of Science and Engineering: Associate Professor Richi Nayak Knowledge to Innovation Brokers: Ken Dusza; Raymond Johnson
Real world context	
KEY TRENDS	<p>Digital transformation of businesses and societies is one of the most significant drivers of the wellbeing of societies and individuals. Data is now recognised as an asset and value driver everywhere in the economy, in every sector and every organisation. Technologies including mobile devices, the Internet of Things, spatial information and big data analytics are having a significant impact on business productivity and processes. New opportunities and industries are emerging, and with them come new challenges and risks relating to privacy, access, security, crime and intellectual property.</p>
GRAND CHALLENGES	<ul style="list-style-type: none"> 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	<p>Our research is designed to drive the following changes in the real world:</p> <ul style="list-style-type: none"> the digital age fosters strong, resilient and inclusive communities. the value of tech businesses and digitally transformed businesses based in Australia increases. individuals benefit from digital transformation through reduced costs of living, access to new services and a higher quality of life.
FOCUSES	<p>We are investigating how to:</p> <ul style="list-style-type: none"> 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.
MEASURES	<p>We are tracking the impact of our research using the following lead indicators:</p> <ul style="list-style-type: none"> difference in number of public services offered in regional versus city locations operational efficiency of partners using QUT technologies number of people trained in QUT structured ideation technique.

Case study: Proactive government in a disrupted world

Project or program	Proactive government service delivery
Research theme	Embracing the Digital Age
QUT team	Professor Marek Kowalkiewicz, Peter Townson, Dr Jeremy Farr-Wharton, Dr Angela Reeve, Dr Ivano Bongiovanni, Matt McNaughton, Professor Michael Rosemann
Partner organisations	Queensland Government
Timeline	2016

Why it matters

Digital disruption is a pervasive feature of contemporary life. It can have a swift and devastating effect on established organisations, including governments. Governments need to move towards a more proactive relationship with citizens, whereby they provide personalised and proactive public services to citizens based on their individual circumstances and needs.

How IFE is making an impact

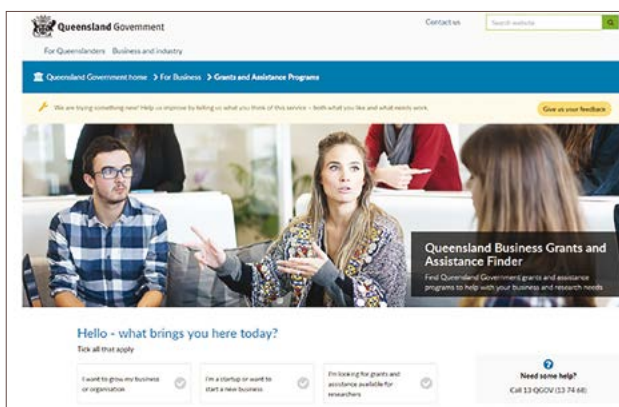
The Queensland Government is rethinking how its services can be delivered by harnessing new technologies to predict citizens' needs and make it easier for them to interact with government. In partnership with QUT, the Queensland Government has been developing several concepts for how government services could be more intuitively designed, personalised and proactively provided. The goal is to connect the community with the services they need before they know they need them.

During 2016, PwC Chair in Digital Economy and IFE Embracing the Digital Age Theme Leader Professor Marek Kowalkiewicz engaged with the Queensland Government to help it adopt a 'proactive government' model to achieve this aim.

Specialist researchers and facilitators from QUT ran nine 'innovation sprints' for the Queensland Government to develop concepts to tackle social problems and proactively deliver solutions. This has resulted in pilots related to:

- reducing red tape for new café owners using an intuitive online assistant
- helping displaced young people to find emergency housing with an interactive, real time, location-based assistant
- helping businesspeople and researchers to find relevant grants and assistance through an interactive online portal.

Customer feedback from these initial pilots has been extremely positive.



Homepage of the Queensland Business Grants and Assistance Finder, one of the pilot tools developed through a QUT innovation sprint

Case study: Smart toilet with a smart business model

Project or program	Affordances of smart meters
Research theme	Embracing the Digital Age
QUT team	Staff: Professor Marek Kowalkiewicz, Dr Alan Woodley, Dr Debra Polson, Associate Professor Rob Perrons, Sara Bennett, Professor Michael Rosemann Students (present and past): Joshua Evans, Damian Grasso, Nabil Parwez, Roshan Pius, Thomas Lloyd, Fraser Miller, Dayna Williamson, Chris Veraa Intolet team: Francis Emil Joash Padilla, Hanis Salwani Othman, Vu Hoang Lam, Nur Sauri Yahaya
Partner organisations	Queensland Urban Utilities
Timeline	2016 - ongoing

Why it matters

Various smart toilets are already on the market, but they have not yet been equipped with sensors to help users and their doctors to monitor and to track their health. Looking at traditional products like toilets in new ways and developing new technologies and business models that take advantage of the digital age can deliver significant benefits to individuals, healthcare providers and society.

How IFE is making an impact

Throughout 2016, QUT researchers from the Science and Engineering Faculty, Creative Industries Faculty and Business School have coached groups of QUT students in developing digital solutions to real world challenges. In February 2016, QUT hosted a Student Design Jam with its innovation partner, Queensland Urban Utilities (QUU). One of the two winning teams developed the concept of equipping a smart toilet with in-built or retrofitted sensors able to detect health or dietary issues then relay this information to the user's mobile phone or a database.

The QUT student team explored the concept further through a QUU internship; they met with laboratory, product development and commercialisation staff and conducted customer research into the perceived advantages and disadvantages of smart toilets. A key finding was that while people are intrigued by the diagnostic toilet concept, they would still like to access the expertise of medical professionals for data interpretation and diagnosis.

In November 2016, a team of QUT MBA business students, Fraser Miller, Dayna Williamson and Chris Veraa, with coaching from IFE Embracing the Digital Age Theme Leader and PwC Chair in Digital Economy Professor Marek Kowalkiewicz, developed a business proposal called 'The Smart Toilet Company' that won the 2016 Global Business Challenge. The Challenge encourages students to design sustainable solutions to global problems and is jointly run by QUT, The University of Queensland and Griffith University, with support from the Queensland Government and industry.



QUT's Chris Veraa, Dayna Williamson and Fraser Miller of The Smart Toilet Company, winners of the 2016 Global Business Challenge

The Smart Toilet Company developed a business model whereby the health of patients could be monitored by conducting urine analysis using small sensors placed in existing toilets. The health data would then be sent to individuals via a smartphone app or be linked in with existing patient information systems used by healthcare providers. This would enable clinicians to analyse a patient's urine sample remotely and compare the results with other patient data to give greater insights into a person's health.

The Smart Toilet Company received \$100,000 for the win. During 2017, the team will continue to work with Queensland Urban Utilities to progress a commercial application of smart toilet technology. Initially, the application is aimed at monitoring patients in Queensland's regional and remote areas, and there is significant early interest from leaders in healthcare and technology.

“This past year, our partnership with QUT has helped accelerate thinking, generate ideas and develop innovative solutions to deliver value for our communities. The staff and students have been invaluable in our Utility of the Future journey.” – Abel Immaraj, Manager, Service Strategies, Queensland Urban Utilities

Enabling platform: IntelliSensing

Leadership	
ENABLING PLATFORM LEADER	<ul style="list-style-type: none"> Professor Tristan Perez
LEADERSHIP TEAM	<ul style="list-style-type: none"> Faculty of Science and Engineering: Dr Matthew Dunbabin; Associate Professor Dian Tjondronegoro; Professor Duncan Campbell; Dr Erin Peterson; Dr Grant Hamilton; Professor Ian Turner; Professor Kerrie Mengersen; Professor Jonathan Roberts; Associate Professor Tomasz Bednarz; Professor Troy Farrell; Dr Kate Devitt; Associate Professor Jim Hogan; Associate Professor Felipe Gonzalez Faculty of Business: Professor Paul Hyland; Dr Udo Gottlieb Knowledge to Innovation Broker: Mr Raymond Johnson

Real world context	
KEY TRENDS	<p>Governments, businesses and individuals often suffer from data overload and yet lack the critical information they need to make sound decisions and address management problems. Society is also on the cusp of a revolution in the way we sense and interact with the world. Technological advances in robotics, autonomous systems, sensor networks, and mobile and wearable devices are generating extraordinary volumes of data and giving us unprecedented power to extract key information that helps us understand and manage natural and built environments. This revolution will transform a wide range of industries and sectors as well as the policy-making processes of governments.</p>
GRAND CHALLENGES	<ul style="list-style-type: none"> 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 robotic and sensing technologies

Our research strategy	
IMPACTS	<p>IntelliSensing is about getting intelligence from sensing. Our research focuses on methods for generating data (sensing), extracting information (intelligence gathering) and using this information to address real world challenges in the built, natural and digital environments. Our research is designed to drive the following changes in the real world:</p> <ul style="list-style-type: none"> 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	<p>We seek to develop solutions to real world problems by investigating how to:</p> <ul style="list-style-type: none"> 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 design innovative cognitively-matched tools including visual analytics to present information so that governments, businesses, citizens and consumers can more easily access and digest large volumes of data and enhance their decision making without reverting to approximate methods understand systems and system behaviors through the use of novel mathematical models and powerful data analytics explore new frontiers in optimisation and computational methods for decision and control strategies that can handle all levels of uncertainty and increased levels of autonomy change and understand limitations of legal and regulatory frameworks to enable the wide application of IntelliSensing solutions across different sectors create programs to transition our education sector to be ready for developing the future workforce who will develop, deploy, and disseminate IntelliSensing solutions across different sectors.
MEASURES	<p>We are tracking the impact of our research using the following lead indicators:</p> <ul style="list-style-type: none"> number of QUT IntelliSensing higher degree research (HDR) students, research fellows and Research in Business staff sponsored by industry and government increasing industry and government situational awareness of changing environments and tipping points number of QUT partnerships to develop commercial IntelliSensing technologies.

Case study: Cutting-edge tool for koala conservation

Project or program	Assessing the Capabilities of Digital Imaging and Unmanned Aerial Systems for Species Management: Koala Abundance
Research theme	IntelliSensing
QUT team	Associate Professor Felipe Gonzalez; Dr Grant Hamilton; Dr Sandra Johnson; Glen Montes; Bryce Kelly; Gavin Broadbent; Dirk Lessner; Dean Gilligan; Dmitry Bratanov
Partner organisations	Logan City Council, City of Gold Coast Council; Tweed Shire Council
Timeline	2016-2017

Why it matters

Koalas are on the brink of extinction in some areas within Queensland and New South Wales. A 2015 landmark South East Queensland Koala Population Modelling Study covering nearly 10,000 square kilometres found that more than 80% of the koala population in and around Brisbane had disappeared since 1996, due to habitat loss, disease and dog attacks. To date, local councils have gathered koala population data by having officers conduct ground-based koala counts, which can be inaccurate, expensive and time-consuming.

How IFE is making an impact

Logan, Gold Coast and Tweed councils, together with QUT, are testing a new tool for protecting their vulnerable koala populations – drones equipped with thermal cameras and artificial intelligence (AI) and backed by powerful statistical analysis. Koala experts from the three councils are working with a transdisciplinary QUT team of researchers and unmanned aerial vehicle (UAV) specialists to develop and trial technologies they hope will prove cheaper and more accurate than current tracking methods.

From July 2016 to January 2017, the research team, led by Associate Professor Felipe Gonzalez, conducted flight campaigns at four sites – Coomera, Pimpama, Logan and Pottsville. The team had developed a unique combination of UAVs with thermal imaging, statistical modelling and AI. While the use of small drones to take images is becoming more common, researchers are combining this capability with cutting-edge analytical technologies that draw meaning from the aerial images. Thermal imaging has been used to detect even well-camouflaged koalas, backed up with counting and tracking algorithms that allow researchers to differentiate the shape of a koala from a possum, birds or other animal.

The technology will not only count koalas but monitor their movements and population fluctuations over time. The regular, accurate monitoring data will allow the councils to better understand the abundance and health of a species



UAV in flight with thermal camera during UAV operations at Pimpama.

in their area and source rich data such as exact GPS locations and high-resolution imaging. While this project is concentrating on koala populations, the technology could easily be adapted for other native or pest species, like wild dogs or feral cats.

The project has already proved the technology can save councils valuable time. In one test, it took humans more than two hours to conduct the same survey a UAV took just 30 minutes to complete. The final results will be analysed and shared with the councils in 2017 to guide future decision making about koala conservation methods.

Research infrastructure for the real world

This project relied on the Australian Research Centre for Aerospace Automation (ARCAA) for expertise in remote sensor technologies, autonomous systems and unmanned aerial vehicles (UAVs).

“This project not only enhances our existing koala conservation plans, it strengthens our koala management opportunities by partnering with our two neighbouring local government areas. Hopefully the results of the trial will prove useful when it comes to monitoring our resident koala populations and future planning for their protection.” – Councillor Cameron Caldwell, City of Gold Coast Planning Committee Chair

Case study: New app helps farmers irrigate vegetable crops more efficiently

Project title	Data Analytics for App Technology in Irrigation Decisions
Enabling platform	IntelliSensing
QUT project team	Professor Tristan Perez, Professor Bronwyn Harch; Associate Professor James McGree; Dr Kate Devitt;
Partner organisations	Horticulture Innovation Australia; The Yield
Timeline	2016-ongoing

Why it matters

Knowing when and how much to irrigate crops can be a challenge for vegetable growers, particularly because only a portion currently use moisture probes to make these decisions on their land. Farmers need accurate, real-time, local and crop-specific data to enable them to make informed decisions about irrigating their crops

How IFE is making an impact

A new mobile app to help vegetable farmers irrigate more efficiently is an exciting new tool for growers, developed as a result of QUT's partnership with agricultural technology company The Yield and Horticulture Innovation Australia.

Initially, the app will allow vegetable growers to enter a location, crop type and crop growth stage to get a quick and easy estimate of crop water use and soil water balance. Ultimately, growers will be able to enter a planting date for their crops and have crop growth stages adjusted automatically, with the new app providing crop-specific water balance predictions. To do this, the app will use information from the Bureau of Meteorology and newly developed 'crop coefficient' data and modelling from this research project.

“

This new app will harness the power of technology to take away some of the uncertainty growers face when deciding when the best time to irrigate is, and how much water might be needed. It's a simple, easy-to-use solution that will help growers improve irrigation efficiency, with flow-on effects for crop yields, profitability and sustainability.” – Hort Innovation Research and Investments General Manager, David Moore

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The app will also have the ability to draw from on-farm microclimate data and analytics where growers have on-farm sensors. The models enabling the app will be developed in partnership with bioinformatics and data analytic experts from QUT. This work involves capabilities in mathematical modelling, real-time statistical inference, decision theory and cognition.

The app was first released in October 2016, with a basic free version and a paid subscription service with added functionality to be available for iOS, Android and Windows platforms. The app will continue to be developed together with growers to ensure that it is easy to use, with a selection of Tasmanian and Queensland vegetable growers already trialling the app.

This research project is being funded by Horticulture Innovation Australia Limited using the vegetable industry levy with co-investment from The Yield and funds from the Australian Government.

“

This project is agile science in action. Instead of waiting three years for research outcomes, we will progressively release updates as the research progresses. This gets results out of the lab and into growers' hands quicker.” – The Yield Managing Director, Ros Harvey

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Enabling platform: Transforming Innovation Systems

Leadership

ENABLING PLATFORM LEADER

• Associate Professor Robert Perrons

LEADERSHIP TEAM

- Faculty of Business: Dr Ozgur Dedehayir; Professor Rachel Parker; Dr Henri Burgers
- Faculty of Creative Industries: Distinguished Professor Stuart Cunningham
- Faculty of Education: Professor Mary Ryan
- Faculty of Health: Professor Neil King
- Faculty of Law: Miss Kylie Pappalardo
- Faculty of Science and Engineering: Professor Michael Rosemann
- Knowledge to Innovation Broker: Mr Andrew Keir

Real world context

KEY TRENDS

The innovation system – the path from discovery to deployment – is not working as well as it could in Australia. Many businesses and organisations do not have ready access to the knowledge and skills they need to be innovators. Asset-intensive industries, such as the energy and resources sectors, are not well served by innovation research or practice, but are eager to be more innovative and increase their rate of technological change. Despite the myriad electronic collaboration tools available, distance still often stifles the innovation process within Australia, and between Australia and the rest of the world.

GRAND CHALLENGES

- Developing the capacity of Australian businesses and organisations to change and innovate faster, so that they remain competitive in a rapidly changing world
- Streamlining the innovation system so that research efforts are not wasted and research breakthroughs benefit society more quickly
- Increasing engagement between industry and the research sector in Australia

Our research strategy

IMPACTS

Our research is designed to drive the following changes in the real world:

- Australian industries have more resilient revenue streams
- Australia focuses more research and development (R&D) resources on projects that matter
- connected innovation is no longer impeded by distance.

FOCUSES

We are investigating how to:

- initiate, conduct and deliver research more effectively so that innovations can be evaluated and adopted more easily by industry, governments, and the public
- develop university–industry relationships that generate new research opportunities and innovation pathways
- help businesses and organisations to develop sustainable revenue streams while still experimenting, adapting and exploiting opportunities
- change business processes, business models, industry structures, and regulatory frameworks to support innovation
- develop innovation management methods that more tightly link research programs to the needs of governments, markets and society.

MEASURES

We are tracking the impact of our research using the following lead indicators:

- median value of industry/government funded research projects to accelerate innovation
- number of projects with industry/government on development and evaluation of impact frameworks
- number of projects that contribute to the development of a 'geography independent innovation environment'.

Case study: Understanding and driving innovation in the energy sector

Project title	Applying Design Structure Matrices to Innovation Systems
Enabling platform	Transforming Innovation Systems
QUT project team	Associate Professor Rob Perrons
Partner organisations	Texas Christian University (TCU), Society of Petroleum Engineers (SPE)
Timeline	2016 – 2018

Why it matters

The design structure matrix (DSM) is a powerful mathematical tool for modelling, visualising, analysing, and improving complex systems, including product architectures, organisational structures, and process flows. DSMs are used in many organisations across diverse industries to help users executing complex processes to identify faster and less risky processes.

Traditionally, the tool has been used in the logistics and operations research domains, but it has recently been applied in new fields such as political science. IFE is investigating whether and how DSMs can be successfully adapted and applied to the innovation domain to shine light on innovation processes.

How IFE is making an impact

Our researchers are using DSMs to examine the flow of ideas, people, and things throughout innovation networks. By using mathematical tools to look at these networks, we hope to deepen our understanding of how these networks work together to deliver new innovations. Our transdisciplinary research team brings together expertise in mathematics, operations, and innovation and technology management.

To trial this approach, IFE conducted a survey with the Society of Petroleum Engineers, a worldwide member organisation for oil and gas industry employees. The survey asked questions about innovation-related behaviours and environmental factors within that industry at an individual level.



The survey's results will be analysed with DSMs to reveal previously invisible industry dynamics and innovation processes within these sectors. By teaching the energy industry how to become more adept at innovation, we hope to improve its ability to deliver the required energy to communities and businesses while minimising the sector's impact on the environment.

To ensure best practice, IFE is collaborating with DSM expert Dr Tyson R. Browning, who is co-author of the book *Design Structure Matrix Methods and Applications* (2012 MIT Press) and Professor of Operations Management at the Neeley School of Business at Texas Christian University (TCU).

Case study: Finding the next big thing in Australian agriculture

Project title	Detecting opportunities and challenges for Australian agricultural and rural industries
Enabling platform	Transforming Innovation Systems
QUT project team	Dr Grant Hamilton, Dr Levi Swan, Dr Sangeetha Kutty, Dr Jared Donovan, Assoc Prof Richi Nayak, Dr Deborah Polson, Dr Markus Rittenbruch, Prof Roger Hellens, Prof Greg Hearn
Partner organisations	Rural Industries Research and Development Corporation
Timeline	2016 – 2018

Why it matters

Understanding the trends that are transforming food production and consumption in Australia and globally is critical to making the Australian rural sector more profitable, sustainable and dynamic. The Rural Industries Research and Development Corporation (RIRDC) wants to better support Australian agriculture by anticipating novel developments that may have a positive or negative impact on rural industries.

How IFE is making an impact

A transdisciplinary team of QUT researchers are working with young agricultural innovators and using their expertise in data scanning, analysis and visualisation to provide the RIRDC and the rural sector with discovery and prediction of emerging trends to facilitate better decision making and innovation.

With a focus on transformative technologies, the project team is identifying issues and themes that are likely to positively or negatively impact rural industries. These include:

- primary production processes and practices
- profitability and growth potential of industries
- new market preferences, trends and opportunities
- adaptive capacity of primary producers and sectors
- requirements for value-adding products, transferring and transporting products to markets
- sustainability pressures, natural resource use and trade requirements.



The project team includes IFE researchers from QUT's Science and Engineering and Creative Industries faculties, who are applying their transdisciplinary knowledge to identify current and emerging trends in the rural sector and mine publicly available data from sources such as Twitter and patents. QUT's trend prediction methodology offers a powerful combination of transdisciplinary industry expertise, data mining and visualisation.



The QUT team has shown their flexibility by aligning to our needs when we have reconsidered how the project might give the best outcomes, and they are moving ahead well in the new direction. I'd happily recommend them to others for the great work they are doing." – Jennifer Medway, Program Manager, Research and Innovation, Rural Industries Research & Development Corporation



Enabling platform: Manufacturing with Advanced Materials

Leadership	
ENABLING PLATFORM LEADER	<ul style="list-style-type: none"> • Professor Ian Mackinnon (interim leader, January to June 2016) • Associate Professor Anthony O'Mullane (appointed leader in July 2016)
LEADERSHIP TEAM	<ul style="list-style-type: none"> • Faculty of Science and Engineering: Professor Ian Mackinnon; Dr Jennifer Macleod; Professor YuanTong Gu; Professor Peter Talbot; Associate Professor Prashant Sonar; Dr James Blinco; Associate Professor Mia Woodruff; Associate Professor Tim Dargaville; Professor Prasad Yarlagadda • Knowledge to Innovation Broker: Mr Ken Duzsa (January to September 2016); Ms Michelle Gane (October to December 2016)

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	<ul style="list-style-type: none"> • 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	<p>Our research is designed to drive the following changes in the real world:</p> <ul style="list-style-type: none"> • more efficient use of resources by global industry • materials have more environmentally sustainable life cycles • industry shares the benefits of new materials with communities.
FOCUSES	<p>We are investigating how to:</p> <ul style="list-style-type: none"> • 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.
MEASURES	<p>We are tracking the impact of our research using the following lead indicators:</p> <ul style="list-style-type: none"> • median value of contracts where industry invests directly in development of materials • number of requested consultations to government on materials lifecycle • number of unique views of QUT media related to impacts of materials on health and the environment.

Case study: A new material that can separate oil from water

Project title	Development of fabrics with multifunctional properties
Enabling platform	Manufacturing with Advanced Materials
QUT project team	Associate Professor Anthony O'Mullane; Dr Faegheh Hoshyargar
Partner organisations	CSIRO; RMIT
Timeline	2016

Why it matters

Oil spills have a devastating effect on land and marine ecosystems, but are extremely difficult to clean up without the use of toxic chemical dispersants, which can sometimes spread oil more widely in the environment.

How IFE is making an impact

Oil spills at sea, on the land or in kitchens could one day easily be mopped up with a new multipurpose fabric that repels water and attracts oil. QUT Associate Professor Anthony O'Mullane, Leader of IFE's Manufacturing with Advanced Materials Enabling Platform, collaborated with researchers from CSIRO and RMIT on the development of the fabric.

The material's unique property was achieved by first adding a copper coating to the fabric, then growing semi-conducting nanostructures on the surface of the material. The nanostructures are like tiny rods that cover the surface of the fabric and attract and hold oil, so that water just runs off. Testing of the fabric has shown it is effective at cleaning up crude oil from both fresh and salt water, and separating organic solvents, ordinary olive and peanut oil from water.

In principle, production of the fabric could be scaled up to be used on massive oil spills that threaten land and marine ecosystems. The fabric is multifunctional and can separate water from other liquids like a sieve; it is self-cleaning, antibacterial and a semiconductor, properties which open up various further applications.

The fabric's antibacterial properties, arising from the presence of copper, could be used to kill bacteria while also separating water from industrial waste in waterways or to decontaminate water in remote and poor communities where water contamination is an issue.

The next step for researchers is to test the scalability of the approach and test whether the material is mechanically robust.

Research infrastructure for the real world

The equipment and staff in IFE's Central Analytical Research Facility (CARF) were critical to understanding the structure and surface chemistry of these fabrics and how that impacted on oil/water separation.



Water sitting on top of the multifunctional fabric.



A scanning electron microscopy image shows the nanoscale features on the individual fibres of the fabric.

Case study: Superconductors come to QUT

Project title	High Temperature Superconducting Propulsion Units for Maritime Applications
Enabling platform	Manufacturing with Advanced Materials
QUT project team	Associate Professor Richard Taylor
Partner organisations	Siemens Australia; Siemens Germany; Australian Government Defence Science and Technology Group
Timeline	2015–2020

Why it matters

Superconducting motors, generators and magnets have the potential to revolutionise many industries – such as the power, transport and maritime industries – through massive gains in energy efficiency. The development and widespread deployment of new superconducting technologies will translate to significant reductions in energy costs and environmental impact.

How IFE is making an impact

QUT is at the international forefront of research to find cleaner and more efficient large-scale motors to power the world’s transport and industry. High temperature superconducting (HTS) motors can carry very high currents compared to conventional technology with virtually no energy loss and could reduce the size and weight of conventional motors by more than 30 per cent.

To move the technology forward, our researchers are collaborating with key players in the private sector and government. In October 2015, QUT signed a landmark five-year research agreement with the German engineering giant Siemens and the Australian Government’s Defence Science and Technology Group.

“The unique partnership reinforces Siemens’ proud record of introducing technologies that matter to Australia ... HTS will also mean less environmental impact and reduced operating costs. Imagine the benefits of a motor with the same power but 30% less size and weight!” – Jeff Connolly, Siemens Australia CEO



Preliminary testing and commissioning of the HTS1 superconducting synchronous machine at Banyo Pilot Plant Precinct.

This partnership will explore how high-temperature superconducting might contribute to Australia’s maritime defence and industrial power requirements. Initially focused on superconducting motors for naval ships, the research partnership will explore various potential uses of HTS technologies.

During 2016, a prototype Siemens HTS superconductor was installed at IFE’s Banyo Pilot Plant Precinct, allowing researchers to begin testing a range of high-temperature superconducting technologies. A superconducting facility has been built within the pilot plant, which includes the Siemens superconducting motor. Additional Siemens equipment is being installed to enable the 400 kilowatt HTS motor to be used in an energy regeneration mode. The long term goal of this project is to evaluate a superconducting propulsion unit on an Australian navy surface vessel in 2020.

This work is being carried out by IFE and the Science and Engineering Faculty and is being led by Associate Professor Richard Taylor.

Research infrastructure for the real world

Located on Brisbane’s north, the Banyo Pilot Plant Precinct is a purpose-built research site for structural, mechanical and electrical engineering. It is equipped with specialist capabilities for large-scale engineering research, testing and validation.

INSPIRING AND NURTURING RESEARCH IMPACT

We engage with industry, government, research organisations and the general public to share our research discoveries and understand the challenges they face.



Events

Grand Challenge Lecture Series

IFE's successful Grand Challenge Lecture Series explores the major challenges confronting humanity in the 21st century and the possible solutions to them. In 2016, IFE presented 13 lectures by eminent speakers on a wide range of topics, including innovation, robotics, nanoscience and biofutures. The lectures were attended by an average of 149 people (including via live stream), a mix of QUT staff and students from every faculty, institute and division, stakeholders from industry and government, researchers from other universities and the general public.

Grand Challenge Lecture	Speaker
The Study of Innovation: Past, Present and Future	Professor Mark Dodgson (The University of Queensland)
Designing Materials for Regenerative Medicine and Ultrasensitive Biosensing	Professor Molly Stevens (Imperial College, London)
Mobile Autonomy a Pervasive Technology: From Self-Driving Cars to Mars – Why Robotics Matters	Professor Paul Newman (University of Oxford)
Planetary Protectors: How Robots Can Help Us Monitor and Maintain the Environment	Dr Matthew Dunbabin (QUT)
Outrageous Events and Sublime Gossip from 40 Years of The Science Show	Robyn Williams (ABC Radio National)
Targeting Nanotechnology at Biomedicine: Engineering Particles for Nanomedicine Applications	Professor Frank Caruso (The University of Melbourne)
The Business and Politics of Technology Innovation: Who Profits and Who Pays?	Professor Rachel Parker (QUT Business School)
The Role of Sustainability and Materials in the New Innovation Economy: Green Materials from Waste Resources	Scientia Professor Veena Sahajwalla (The University of New South Wales)
Light, Nanoscience and the Future of Solar Power	Professor Jean-Michel Nunzi (Queen's University, Canada)
Being Human in a Digital Age	Professor George Siemens (The University of Texas at Austin)
Biofutures: Sustainable Industries for Queensland's Future Economy	Professor Ian O'Hara (QUT)
Transforming Farming and Food Systems with Digital Technology	Ros Harvey (QUT; The Yield)
The Innovation Skill Set: What We Can Learn From Australia's Most Innovative Enterprises	Distinguished Professor Stuart Cunningham (QUT)



Scientia Professor Veena Sahajwalla (University of New South Wales) and Robyn Williams (ABC Radio National) giving their Grand Challenge Lectures in 2016.

Distinguished Visitor Lecture Series

In 2016, IFE hosted 32 lectures in its Distinguished Visitor Lecture Series, which gives experts from academia and industry a forum for discussing the key trends, issues and opportunities in their fields. The 2016 lectures, which covered a diverse range of topics connected to IFE's research themes and enabling platforms, were attended by 33 people on average.

Distinguished Visitor Lecture	Speaker	Primary IFE research theme, platform, facility or allied centre
Nanoscience and Nanotechnology @ NEST (National Enterprise for Nanoscience and Nanotechnology)	Professor Fabio Beltram (Scuola Normale Superiore di Pisa)	Manufacturing with Advanced Materials
Long Live the Algorithm But For Which Vision of Higher Education?	Professor Simon Buckingham Shum (University of Technology Sydney)	ARC Centre of Excellence for Mathematical & Statistical Frontiers
From 100mL to 2600m ³ : Design through Commercial-scale Implementation of an Advanced Biofuel Yeast Strain	Dr Paul Taylor (Ingenza Ltd)	Growing the Global Bioeconomy
Introduction to Design Structure Matrix (DSM) Methods and Applications	Dr Tyson Browning (Texas Christian University)	Transforming Innovation Systems
Multifunctional Materials for Electronics and Photonics	Professor Federico Rosei (Université du Québec, Canada)	Manufacturing with Advanced Materials
Quantum Emitters in Wide Bandgap Semiconductors	Associate Professor Igor Aharonovich (University of Technology Sydney)	Manufacturing with Advanced Materials
Mechanism of Forming of Protein Ion 'Superacids' by Electrospray Ionisation	Dr William (Alex) Donald (University of New South Wales)	Manufacturing with Advanced Materials
Using Nanocarbons in Novel Solar Cells	Professor Joe Shapter, Flinders University	Manufacturing with Advanced Materials
Deep Learning in the Shallow Seas: How Deep Neural Networks are Revolutionizing Automated Annotation of Coral Reef Survey Imagery	Dr Oscar Beijbom, UQ Global Change Institute/Berkeley Vision & Learning Center	ARC Centre of Excellence for Mathematical & Statistical Frontiers
Pacific Northwest National Laboratory (PNNL): Transforming the World Through Courageous Discovery and Innovation	Dr Douglas Ray (PNNL)	Growing the Global Bioeconomy
The Caveats of Digitization	Professor Varun Grover (Clemson University)	Embracing the Digital Age
Taking a Step Back in Ecological Science: Understanding Community Assembly in Space and Time	Professor Marc Cadotte (University of Toronto)	Managing for Resilient Landscapes
Photoredox Catalysis: Organic Synthesis with Visible Light	Professor Burkhard Konig (University of Regensburg, Germany)	Manufacturing with Advanced Materials
Gas Phase Structure and Reactivity of Isomer Separated Metal Complexes and Cages Relevant to Catalysis and Gas Capture	Dr Nicole Rijs (Karlsruhe Institute of Technology, Germany)	Central Analytical Research Facility
Chemistry of the Rare-Earth Elements: Homogenous Catalysis and Unusual Compounds	Professor Peter Werner Roesky (Karlsruhe Institute of Technology, Germany)	Manufacturing with Advanced Materials

Distinguished Visitor Lecture	Speaker	Primary IFE research theme, platform, facility or allied centre
Case Studies in Evolutionary Medicine	Professor Allen Rodrigo (Australian National University)	Growing the Global Bioeconomy
Innovators: Neglect Communication at Your Peril	Dr Andrew Powell (CEO, Asia BioBusiness Pte Ltd)	Transforming Innovation Systems
Improving Adaptation to Climate Variability and Change in the Agricultural Sector	Dr Walter E. Baethgen (Earth Institute, Columbia University)	Managing for Resilient Landscapes
2016 Australian Academy of Science David Craig Lecture: Basic Chemical Theory and Understanding Nanoparticle Synthesis, 2D Nanostructures and Photosynthetic Function	Professor Jeffrey Riemers (University of Technology Sydney and Shanghai University China)	Manufacturing with Advanced Materials
How to Get the Most Value from Your Great Idea	Associate Professor Tim Kestelle (The University of Queensland)	Transforming Innovation Systems
2016 Australian Academy of Science Rudi Lemberg Lecture: Alfred Nobel and the Nobel Prize – A History with Relevance to Australia	Professor Lawrence Berliner (University of Denver)	General
Exploiting Nanotechnology to Probe Mechanical Properties of Single Molecules and Single Cells	Professor Massimo Vassalli (National Research Council, Italy; Victor Chang Cardiac Research Institute)	Manufacturing with Advanced Materials
Mesostructuring of Complex Semiconductor Oxides: Materials Design for Solar Energy Conversion	Dr Roland Marschall (Justus-Liebig University, Giessen)	Manufacturing with Advanced Materials
Electrochemical Sensing Strategies for Aquatic Systems Analysis	Professor Eric Bakker (University of Geneva, Switzerland)	Manufacturing with Advanced Materials
Fermentation for Cost-Effective Production of Bioethanol from Sweet Sorghum	Dr Shizhong Li (Tsinghua University, China)	Growing the Global Bioeconomy
Long-read SMRT Sequencing for New Insights into Genomes, Epigenomes and Transcriptomes	Dr Jonas Korfach (PacBio)	Central Analytical Research Facility
The Nanoscale Playground: Developing Materials and Techniques for Applications as Diverse as Cancer Therapy and Quantum Computing	Associate Professor Justin W Wells (Norwegian University of Science and Technology)	Manufacturing with Advanced Materials
Modern Spatial Statistics for Natural Sciences: Big Data and Complex Domains	Dr Jay Ver Hoef (National Oceanic Atmospheric Administration)	Managing for Resilient Landscapes
Micro-Nano Technologies for Analysing Tiny Samples & Manipulating Single Cells	Professor Janos Vörös (Institute for Biomedical Engineering, ETH Zurich, Switzerland)	Manufacturing with Advanced Materials
2016 Australian Academy of Science Selby Fellowship Lecture: Renewable Energy Technologies and Climate Change – Humanity's Grand Challenges in the 21st Century	Professor Federico Rosei (Université du Québec)	Manufacturing with Advanced Materials
Flexible and Printed Organic Electronics: Overview of Printable Materials, OTFT Devices, and Applications	Professor Shizuo Tokito (Yamagata University, Japan)	Manufacturing with Advanced Materials
Advanced Membrane Science and Technology for Water and Environment	Professor Rong Wang (Singapore Membrane Technology Centre)	Managing for Resilient Landscapes

Cyber Security Information Session for Industry and Government: Protecting your Critical Information

On 24 February 2016, QUT hosted an information session for industry and government providing the latest expert advice on cyber security risks and how they can be mitigated from industry professionals and researchers. Speakers included Gavin Coulthard (Palo Alto Networks), who discussed trends related to information security attacks, data breaches and threats; Helen Clarke (Corrs Chambers Westgarth), who presented on cyber security best practice from a legal perspective, including how to comply with regulatory requirements and respond to a breach; and Dr Ernest Foo (QUT), who outlined current research issues and future directions related to protecting critical infrastructure and industrial control systems against cyber-attacks.

Mining & Energy in 2025 & Beyond: Technology Symposium and Student Hackathon

On 26 May, IFE hosted a technology symposium for the mining industry, government and academia, supported by the prestigious Massachusetts Institute of Technology (MIT) Mining, Oil and Gas Club, the Queensland Government and METS Ignited. Around 135 stakeholders had the opportunity to learn about innovations in mining and energy, engage with industry experts and experience cutting-edge technologies. Keynote speakers included Dr Frank O'Sullivan from MIT and Anna Littleboy from the CSIRO. Dr Anthony Lynham, Queensland Minister for State Development/Minister for Natural Resources and Mines, also joined the event to participate in a panel discussion.

The following day, members of the MIT Mining, Oil and Gas Club facilitated a student hackathon at QUT to deliver innovative solutions to 'real world' challenges and questions facing the mining and oil and gas industries both in Australia and globally. Students from all disciplines were invited to solve one of three industry challenges related to reversing declining grade, tracking coarse material streams and finding uses for water produced from coal seam gas. The winning teams received prizes sponsored by the Cooperative Research Centre for Optimising Resource Extraction (CRC ORE).



(L-R) Panel discussion at the technology symposium; student hackathon; visiting members of the MIT Mining, Oil and Gas Club with QUT's Associate Professor Rob Perrons and METS Ignited's Ian Dover

Real World Futures 'Dining Disrupted' event

On 29 August, QUT's Real World Futures program hosted a forum called 'Dining Disrupted' that explored how technology is changing what we eat and how we produce our food. IFE researchers Professors Tristan Perez, Peter Waterhouse, Roger Hellens and Sagadevan Mundree gave insights into how robots are changing the agricultural world; the fight to keep the banana a disease-free and affordable staple for Australian families; the pioneering introduction of red kiwifruit to our menus; and the rise of the mung bean as a valuable commodity. Ros Harvey, founder and managing director of The Yield, also spoke on marrying big data with food production.

Übercamp: a masterclass on how to change the world

On 7 & 8 September, 26 of QUT's brightest students and early-career researchers attended the university's second Übercamp. Participants were guided on how to set and refine their entrepreneurial ideas and present a 90-second "elevator pitch" to a panel of expert judges and potential investors. Übercamp was developed by QUT bluebox chairman, biotech pioneer and former Queensland Chief Scientist Peter Andrews and science and innovation policy analyst Fiona Wood, and is based on their book *Überpreneurs: How to Create Innovative Global Businesses and Transform Human Societies*. The 2016 Übercamp program featured inspiring guest speakers Dr Tracey Brown, biotechnology entrepreneur and Victorian Telstra Business Woman of the Year and David Poxon, winner of Übercamp in 2015. This year's winning pitch was delivered by QUT Science and Engineering Faculty academic Dr Mariam Darestani, who impressed judges with her irrigation filtration system, which has the potential to revolutionise Australian agriculture and benefit a billion people worldwide without access to clean water.



The Übercamp class of 2016

On 16 November, a follow-up event called Überchat highlighted the journeys of 2015 and 2016 Übercamp graduates in a discussion facilitated by Peter Andrews. Speakers included Michael Trotter, whose new start-up LagSwitch uses computer gaming techniques to engage students in learning; Natalie Bowring, who is developing products to combat the rise of sexually transmitted diseases in the over-50 age group; and David Poxon, whose start-up company Velvet allows people to sell their unused wi-fi internet data to people nearby (see page 40).

QUT Microbiome Workshop

QUT held a Microbiome Workshop on 7 September to unite investigators across the university conducting microbiome research in areas such as the environment, agriculture, industry and biomedicine, as well as researchers in the fields of bioinformatics, information technology and mathematics. The workshop, designed to drive collaboration on large-scale collaborative microbiome-focused projects, was a joint initiative of IFE's Growing the Global Bioeconomy research theme and the Institute of Health and Biomedical Innovation's (IHBI's) Chronic Diseases and Ageing research theme.

UAV Challenge

In September 2016, unmanned aerial vehicle (UAV) or drone experts and enthusiasts from five countries came together to compete in the CSIRO-QUT jointly run UAV Challenge in Dalby. Ten teams – five from Australia, two from Poland and one each from Canada, Thailand and the Netherlands – completed the Medical Express mission, which involved flying their autonomous aircraft from the Dalby Model Aero Club to a remote landing site over 10 kilometres away, retrieving a blood sample from Outback Joe, then returning to base with the blood sample within one hour. QUT Professor of Robotics, Jonathan Roberts, is involved in organising the Challenge, which he sees as a key way of driving forward UAV technology and its ability to serve the community. High school students from Australia, China and California also competed in a separate lifesaving medical challenge using UAVs near Ipswich.

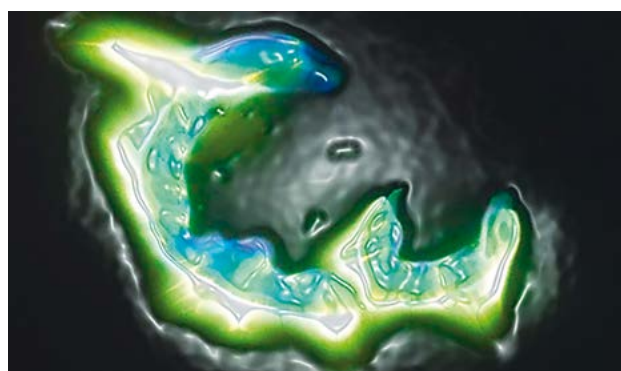
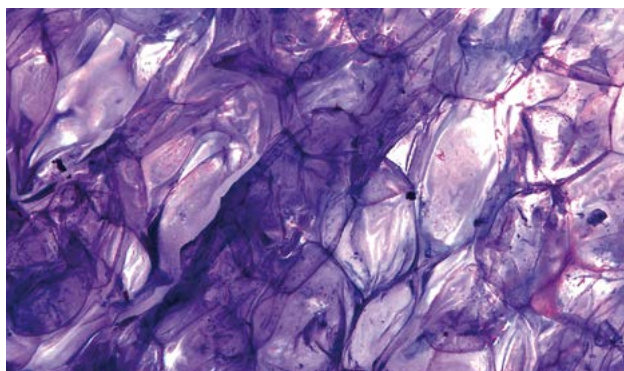
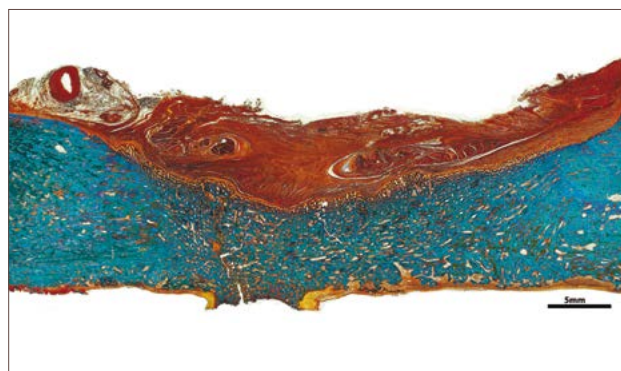
Bright Ideas: Smart Lighting for Smart Cities Forum

LED streetlights are evolving as a technology that can provide local councils with energy-efficient and cost-effective outdoor lighting solutions, and have already been installed in countries including the USA, Canada and the United Kingdom. On 21 October, around 100 stakeholders from government, industry and academia came to QUT to hear results of technical LED street light trials in Queensland and business model ideas to move widespread deployment of the technology forward. The forum was presented by the Guided Innovation Alliance (GIA), an industry–research alliance, comprising QUT, Ergon Energy and SmartGrid Partners, that aims to shorten the pathway to market for new innovations in the electricity sector.

QUT Science in Focus Image Competition

IFE launched the QUT Science in Focus Image Competition in 2016 to celebrate original, informative and technically innovative images that tell the stories behind important QUT research. This evolved from the popular QUT Nikon Small World Competition, held in 2014 and 2015, which showcased QUT's finest light microscopy images. In 2016, the entry conditions were broadened to include photographs, light and electron microscopy, hand-drawn and digital illustrations, machine outputs and scans, x-rays, infographics, graphs and 3D images. The judges were impressed with the diversity and creativity of the 120 entries by QUT students and staff.

The winning images were announced at a finalist exhibition and cocktail function attended by 80 people at The Cube on 28 October, and have also been included in a finalist gallery on IFE's Flickr page. Associate Professor Michael Milford won the QUT staff and student category for his 'Brisbane Flooding Striplapse' image, which shows the striking change in local riparian zones during flooding events. The People's Choice Award went to Charith Rathnayaka Mudiyansele for his eye-catching image of the cellular structure of a dried apple, which received over 500 votes. The senior high school category was won by William Crain from Tullawong State High School for his image of a copper solution burning.



Winning images from the 2016 QUT Science in Focus Competition: (Top row, L to R) Michael Milford's Brisbane flooding striplapse image; Flavia Medeiros Savi's image of a bridged defect in a sheep tibia; (Bottom row, L to R) Charith Rathnayaka Mudiyansele's image of a dried apple's cellular structure; William Crain's image of a burning copper solution.

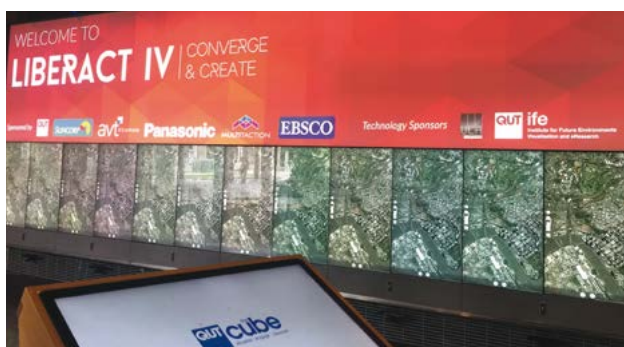
Brisbane Climathon

QUT hosted Brisbane's first Climathon on Saturday 29 October, as part of a worldwide initiative to empower ordinary people to generate ideas to address climate change. The Climathon concept was established in 2015 by the Climate-KIC Program, and events take place simultaneously in more than 80 cities around the world, bringing together students, academics and concerned members of the general public. At the Brisbane event, local participants worked in groups guided by expert facilitators to develop their ideas about how to make Brisbane more resilient to climate 'shocks' such as flooding, drought and heatwaves. Attendees heard inspirational talks from Professor Michael Rosemann (QUT), Amanda Gearing (journalist and author), Troy McGrath (CitySmart) and Michael Howes (Griffith University). Each group then pitched their idea to a judging panel. The winning concept was a plan to establish a trail of community gardens along Brisbane's public transport routes to raise community awareness of ethical food production, consumption and waste management through an interactive, participatory experience. The Brisbane Climathon was a collaboration between IFE and Griffith University's National Climate Change Adaption Research Facility, and was sponsored by Suncorp.



Liberact IV: Converge and Create

From 31 October to 1 November, IFE's Visualisation and eResearch (ViseR) team hosted the international Liberact conference, which was being held in Australia for the first time. Centred at The Cube at QUT, the event brought together leaders, creators and builders of digital interactive experiences in public, corporate and academic spaces worldwide. The event focused on the design, development and management of digital spaces and content using next-generation AV, IT and smart building technology. Along with plenary presentations, the event featured, for the first time, a technology hall where vendors and end-users staged demonstrations of the next generation of virtual reality, holographic computing and large-scale digital displays. Liberact IV inspired and challenged delegates to imagine how high-impact, memorable experiences can be delivered to an ever growing market of highly expectant digital natives.



Liberact comes to The Cube



Projection mapping on Old Government House

Samford Ecological Research Facility (SERF) Annual Information Session

On 20 October 2016, 30 Samford residents and stakeholders attended the annual information session at IFE's Samford Ecological Research Facility (SERF) to hear about the research, education and outreach activities conducted at SERF during the year. The speakers included IFE's Distributed Sites and Infrastructure Manager Dr Juan Cooper, Field Technician Marcus Yates, and Russell Beddoes, winner of the 2015 Dr E.N. Marks Sustainability Award for his research into the use of thermal imaging for ecological surveys. Visitors also enjoyed viewing segments from TV programs *Totally Wild* and *Scope* that highlighted the water quality and eco-acoustics research being done at SERF.

Data & Privacy Public Forum

IFE and the QUT Faculty of Law hosted a public forum on data and privacy on 24 October. The Australian Privacy Commissioner and Information Commissioner, Timothy Pilgrim, and the Queensland Privacy Commissioner, Philip Green, discussed contemporary interactions between privacy, governance, technology and trust with the audience of 80 people from QUT and the public. Also on the panel were QUT's Professor Marek Kowalkiewicz, Leader of IFE's Embracing the Digital Age research theme, and intellectual property and information law expert Dr Angela Daly.

Transdisciplinary Symposium on Genome Editing

On 9 December, IFE hosted a transdisciplinary symposium about the technical, legal, social and ethical challenges involved in genome editing and emerging technologies such as CRISPR. Speakers included biomedical technology expert Josephine Johnstone from The Hastings Centre; Gaetan Burgio from the John Curtin School of Medical Research and Sébastien Cunnac from France's Research Institute for Development.

STEM high school engagement program

IFE played a key supporting role in the STEM High School Engagement program run by the QUT Marketing and Communication Department. For the first time, IFE hosted students within the Central Analytical Research Facility (CARF) as part of the QUT High School Research Internships program. This exclusive week-long program accepted 24 of the state's top Year 12 science students to work under the mentorship of QUT scientists. Ten students worked in CARF's laboratories, undertaking advanced science and engineering research. These were the first ever high school students to gain full access to CARF's Mass Spectrometry Development Laboratory, Surface Science Laboratory, X-ray and Particles Laboratory and Histology Laboratory. IFE's facilities and staff received extremely positive feedback from the students.

“The facilities were amazing and far beyond what I have seen or used before. Using the equipment we had access to was an incredible privilege.” – Intern, CARF's Mass Spectrometry Development Laboratory

“A very engaging week where I really learnt what research looked like... the facilities were top-notch and this was very exciting.” – Intern, CARF's X-ray and Particles Laboratory



High school internship students learning about scientific methods from Professor Stephen Blanksby in the Mass Spectrometry Development Laboratory in IFE's Central Analytical Research Facility

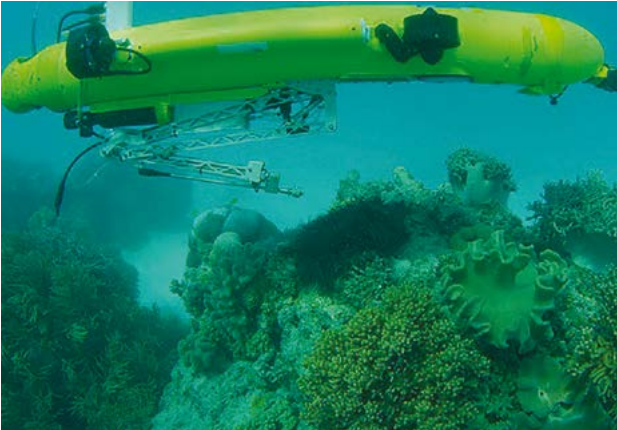
For the fourth year, IFE continued its support of the QUT Vice-Chancellor's STEM Camp, which gave 160 high-achieving Year 11 students from across Queensland the opportunity to work for a week with QUT staff on research projects addressing some of the grand challenges faced by society this century. Several of the projects were developed and run in IFE facilities by IFE researchers, with students being exposed to a broad range of technologies and topics, such as stress responses in plants, maths for imaging and virtual reality, organic electronics, robotics and unmanned aerial vehicles (UAVs).

IFE also worked with the STEM High School Engagement team to deliver a high school category in the 2016 QUT Science in Focus Image Competition. Senior high school students were invited to enter eye-catching images that capture how STEM impacts our world (see page 37).

Media

During 2016, a wide variety of local, national and international media outlets ran stories about IFE researchers, projects and events. Three of the major stories are described below, and some of the other media highlights from 2016 are listed in the table.

COTSbot: Robo reef protector to save Great Barrier Reef



It was a huge year for Dr Matthew Dunbabin and Dr Feras Dayoub and their COTSbot. The pair proved COTSbot can autonomously detect and inject crown-of-thorns starfish, they were Eureka Prize finalists and they won a \$750,000 Google Impact Challenge grant to transform their robot into an all-purpose RangerBot. During the year, the COTSbot was featured in local and international media including 612 ABC, ABC Cairns, Cairns Post, Sunday Mail, 10 News, 7 News, Herald Sun, The Australian, news.com.au, New Scientist, Catalyst, WIRED, Australian Manufacturing, Chosun Biz, pedestrian.tv, Gizmodo, MSN NZ, Business Insider and IFL Science.

New technology helps conserve jaguar habitat in the Amazon



Jaguars in the wild jungles of Peru are among the most elusive and threatened species on the planet. QUT researchers, led by Distinguished Professor Kerrie Mengersen, pioneered a visionary project to help preserve jaguar habitats through the use of statistics, mathematical modelling, virtual technology and knowledge from Indigenous people living in the Amazon. The story attracted significant media coverage during April and May, including in The Weekend Australian, Huffington Post, Mashable, Fortune, Brisbane Times, Sun Herald, Australian Business, ABC Radio, The Conversation, MiNDFOOD, ScopeTV and the ABC Radio Science Show.

Brisbane entrepreneur creates Wi-Fi sharing economy



QUT PhD student and software engineer David Poxon launched his own start-up company, Velvet, which allows people to sell their unused internet data to other nearby people via wi-fi. Mr Poxon's data sharing idea was the winning pitch at the inaugural QUT Übercamp – a masterclass co-sponsored by IFE and qutbluebox to nurture the next generation of global entrepreneurs, or 'überpreneurs'. David's start-up received comprehensive media coverage during September and October, including in The Courier Mail, Sunrise, ABC Radio, The Drum, Brisbane Times, Reckoner, Australian Business Network, The Guardian, DailyMail, Tempo, Technology Champ and Telecom Asia.

Media highlights in 2016

Month	Topic	Researcher/s	Media outlet/s	IFE theme/platform
Jan/Feb	Biofortified banana research in Uganda	Prof James Dale	Good Morning America	Growing the Global Bioeconomy
	Use of sugarcane bagasse for animal feed	Assoc Prof Robert Speight	ABC Radio Rural Report	Growing the Global Bioeconomy
Mar/Apr	What smart organisations will do in the future	Prof Marek Kowalkiewicz	Gold Coast Bulletin	Embracing the Digital Age
	New fabric with semi-conducting nanostructures used for cleaning up oil spills	Assoc Prof Anthony O'Mullane	Gizmag, Controlled Environmental Magazine, pddnet.com, Sustainability Matters, Science Alert, Engineering News & Analysis	Manufacturing with Advanced Materials
May/June	Sugar industry reliance on fossil fuels	Prof Ian O'Hara	Fairfax Media, ABC Radio, Queensland Industry Advocate, Biofuels Digest, Agfax	Growing the Global Bioeconomy
	QUT research agreement about superconductors between Siemens and the Australian Government's Defence Science and Technology Group	Rob Hickey	Manufacturers Monthly, Quest	Manufacturing with Advanced Materials
Jul/Aug	Ecological soundscape research	Jessie Cappadonna, Prof Paul Roe, Dr Susan Fuller	ABC Catalyst, ABC Online, Can Mua	Growing the Global Landscapes
	Warnings about chance of attack on Census website by 'hacktivists'	Dr Ernest Foo	The Courier Mail, News Corporation, The Herald Sun, Daily Telegraph, news.com, The Vine	Embracing the Digital Age
	Advances in nanotechnology and computing	Prof Nunzio Motta	SBS	Manufacturing with Advanced Materials
Sept/Oct	Impact of halo blight disease on the mungbean industry	Prof Sagadevan Mundree	Queensland Country Life, Australian regional media, The Land, ABC Southern Queensland, ABC Wide Bay	Growing the Global Bioeconomy
	QUT's new agricultural weed-killing robot AgBot II	Prof Tristan Perez	ABC Country Hour, ABC radio across Australia, ABC TV, Huffington Post, Bundaberg News Mail, Gizmodo, Queensland Country Life	IntelliSensing
Nov/Dec	Virtual reality project to measure the aesthetic value of the Great Barrier Reef	Dr Erin Peterson, Dr Julie Vercelloni	612 ABC, AustraliaPlus, TribunNews, Tempo	IntelliSensing
	QUT research agreement with Sumitomo Electric for a concentrated solar photovoltaic demonstration project in Queensland	Prof Ian Mackinnon	The Sunday Mail, Mackay Daily Mercury, other regional press	Manufacturing with Advanced Materials
	Rigorous testing of a new rubber tyre biofuel at the QUT Biofuel Engine Research facility	Prof Richard Brown	ABC TV News, ABC Online, Radio Australia, 4ZZZ, Gizmodo, New Atlas, Industry Update, Manufacturers' Monthly, National Newspaper (PNG)	Growing the Global Bioeconomy

Digital and social media

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

The IFE website, which is part of the QUT corporate website, contains detailed information about IFE's research programs, centres and facilities, as well as our events for the general public, staff and industry. The site attracted 8,796 visitors during 2016.

Twitter (@IFE_QUT)

Twitter has been a significant engagement channel for IFE. We tweeted at least once a day throughout 2016, sharing news of research activities and achievements, upcoming events, new equipment and interesting articles and blogs relevant to IFE's research areas. By December 2016, IFE's Twitter account hit the milestone of 1,000 followers, more than doubling the number of followers since December 2015 (480 followers).

QUTube

IFE has a playlist within QUT's YouTube channel, the QUTube, containing videos of IFE lectures and highlighting key research projects. This channel helps to increase the reach and impact of our work. In 2016, we added videos about AgBot II and Harvey the robotic capsicum harvester.

Flickr

In 2016, our Flickr collection grew to over 980 images of IFE staff, facilities and events. This year, we added to the growing library of images by profiling our researchers, facilities and several major events, such as the Science in Focus Image Competition, Brisbane Climathon, Übercamp and the Mining & Energy 2025 & Beyond Technology Symposium and Student Hackathon.



IFE @IFE_QUT · 29s

We now have a tonne of followers thank you! 🎉 Stay tuned as our [#research](#) & [#innovation](#) makes the world more [#sustainable](#) [#secure](#) [#resilient](#)



Awards and scholarships

Awards received by the IFE

Statistical Society of Australia Pitman Medal

Distinguished Professor Kerrie Mengersen was awarded the Statistical Society of Australia Pitman Medal, which recognises outstanding achievement in the field of statistics. It is the first time that the Medal has been awarded to a female statistician. Professor Mengersen is a national and international leader in her field and her applied research has had a significant impact on science in different domains. In 2015, Professor Mengersen was made an Australian Laureate Fellow and is currently a Deputy Director of the ARC Centre of Excellence in Mathematical and Statistical Frontiers (ACEMS), which has one of its largest nodes at QUT.



2016 McCullough Life Sciences Queensland Industry Excellence Award

Professor Sagadevan Mundree, Director of QUT's Centre for Tropical Crops and Biocommodities (pictured second from right), was awarded the 2016 McCullough Life Sciences Queensland Industry Excellence Award, which is presented to an individual that has made significant contributions to the performance and success of the Queensland life sciences industry and has demonstrated a breadth of impact across the sector. The award was presented at the Globally Engaging Networking Event (GENE) held on 21 October 2016.



Queensland's 2016 Women in Technology award

Women in Technology (WIT) is the peak industry body for women in technology and life sciences within Queensland. At its annual award ceremony on 2 September 2016, QUT **Associate Professor Dr Richi Nayak** was awarded the Infotech Outstanding Achievement Award for her work in data mining and web intelligence, which has helped her obtain over \$1.5 million in competitive external research funding over the past five years.



Design award for AgBot II

IFE's **agricultural robotics research team** received the runner-up prize in the 2016 Design Entrepreneur Awards for AgBot II. The awards, a partnership between Good Design Australia and business accelerator CtechBA, recognise innovative ideas for new products and services that are yet to be commercialised. Industrial designer Owen Bawden and Senior Research Associate Raymond Russell pitched the AgBot II concept and received the \$5000 award in Sydney in May.



RangerBot voted Google Impact Challenge People's Choice Winner

The Google Impact Challenge awarded over \$5 million to ten Australian non-profits with big ideas for a better world. There was a tie for the People's Choice Winner, with the Great Barrier Reef Foundation receiving a \$750,000 grant to enable QUT researchers to build on the successful COTSbot platform to create the RangerBot, a low-cost, vision-enabled autonomous underwater vehicle. COTSbot's creators, **Dr Matthew Dunbabin** and **Dr Feras Dayoub**, plan to expand the current platform's functionality into a multipurpose, multifunction tool for monitoring a wide range of issues facing coral reefs, including coral bleaching, water quality, pest species, pollution and siltation.

2016 Australian Museum Eureka Prize finalists

Presented annually by the Australian Museum, the Australian Museum Eureka Prizes reward excellence in the fields of research and innovation, leadership, science communication and school science. The **QUT Environmental Robotics team** from the ARC Centre of Excellence for Robotic Vision) was a finalist in the 2016 Research and Innovation category. The team has developed a revolutionary robotic system, COTSBot, to increase the efficiency of crown-of-thorns starfish (COTS) control programs. Through innovations in robotic vision, machine learning and robotic navigation, COTSBot provides a versatile tool aimed at empowering stakeholders undertaking COTS control programs for protection of the Great Barrier Reef.

Associate Professor Michael Milford was a finalist for the 2016 Macquarie University Eureka Prize for Outstanding Early Career Researcher. Associate Professor Milford's research bridges the divide between robotics and neuroscience. He has created new algorithms and technologies for robotics that are now being developed for a wide range of applications including mining, infrastructure monitoring, environmental analysis, space exploration and self-driving cars.



Molecule of the Year finalist

CARF mass spectrometry researcher **Dr Berwyck Poad**, together with colleagues at the Australian National University, University of Sydney and University of Wollongong, has developed a molecule called ortho-diethynyl benzene dianion said to be the 'world's strongest chemical base'. It has the highest reported gas-phase proton affinity. The molecule was shortlisted by C&E News (published by the American Chemical Society) for its 2016 Molecule of the Year competition.



Awards and scholarships sponsored by the IFE

Dr E.N. Marks Sustainability Award

Since 2008, IFE has presented an annual award to recognise a QUT undergraduate student for a high quality research project that contributes to the environmental integrity of the Samford Ecological Research Facility (SERF) and engages the university and the wider community. The award is named in honour of Dr Elizabeth Nesta (E. N.) Marks AO, a renowned Queensland entomologist who generously bequeathed the SERF property to QUT. The 2015 Dr E.N. Marks Sustainability Award was presented to **Russell Beddoes** for his research project examining the use of thermal imaging for ecological surveys, which involved studies in both controlled laboratory conditions and in the field at SERF. Russell is now part of QUT's Quantitative Applied Spatial Ecology research group and will commence his Masters studies in 2017.



Student Russell Beddoes receiving his award from IFE's Dr Juan Cooper

Siganto Foundation Medal

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

The 2016 Medal recipient was **Dr Nayim Kabir**, whose PhD thesis was titled *Smart Coordinated Distribution System Control to Enable High Level Penetration of Rooftop PVs*. During his PhD candidature, Dr Kabir's work was published via three conferences, four journals and one book chapter, and he has been cited at least 40 times in subsequent publications. Dr Kabir currently works as Senior Advisor – Energy Projects at Local Government Infrastructure Services (LGIS). His future career ambitions include further research collaborations, and developing a cluster or community based consolidated autonomous micro-grid system that combines renewable energy generation and energy storage.



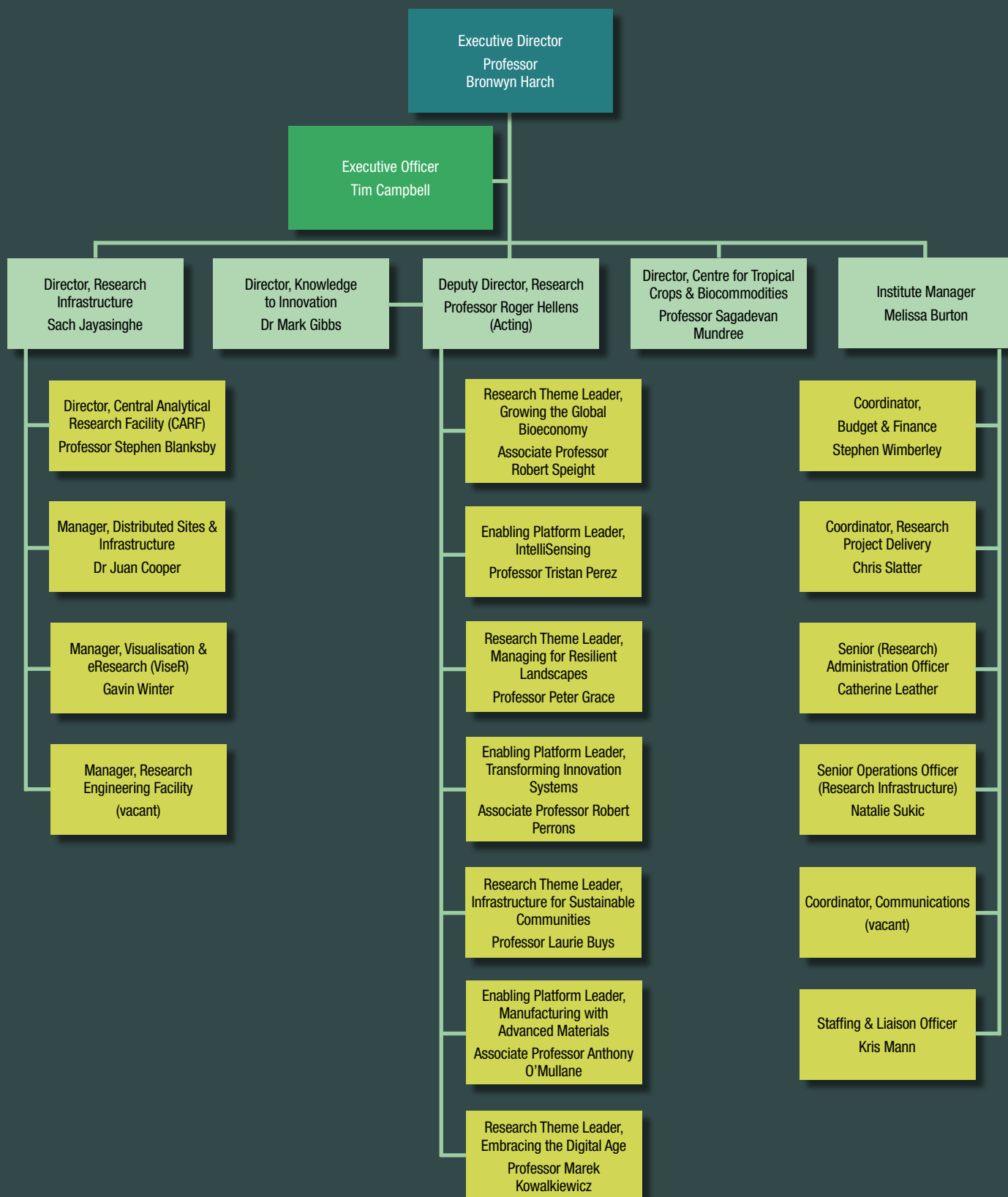
Dean of QUT's Science and Engineering Faculty, Professor Gordon Wyeth, with 2016 medal winner Dr Nayim Kabir

PEOPLE AND GOVERNANCE

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



Organisational structure



Current as at 31 December 2016.

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, technical 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, communication, knowledge to innovation brokering, human resources and administration
- **Technical staff** in IFE's research facilities, including the Central Analytical Research Facility, Samford Ecological Research Facility (SERF), Banyo Pilot Plant Precinct, Mackay Renewable Biocommodities Pilot Plant, Visualisation and eResearch (ViseR) team, Australian Research Centre for Aerospace Automation (ARCAA) and Queensland Crop Development 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 (HDR) students**, including:
 - students supported by IFE scholarships
 - students supervised by academic staff aligned with the 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.



Appointments



Executive Director

Professor Bronwyn Harch commenced as Executive Director of the Institute on 1 July 2016. Bronwyn had been the Deputy Director of IFE since June 2014 and had played an integral role

in developing the strategy and structure of IFE's research themes and enabling platforms. Before joining QUT in June 2014, Bronwyn was the Chief of CSIRO's Division of Computational Informatics and previously the Deputy Director of CSIRO's Sustainable Agriculture Flagship. She is an applied statistician and research leader with two decades of experience working across the agriculture, environment, health, manufacturing and energy sectors. In late 2016, Bronwyn joined the board of Innovation and Science Australia, an independent statutory board that provides strategic advice to the Australian Government on all science, research and innovation matters.

Bronwyn took over as Executive Director from Professor Ian Mackinnon, who had led IFE since its inception and been one of the driving forces behind the shift to a transdisciplinary research culture at QUT. Ian will continue to be heavily involved in the Institute as a researcher and mentor.



Director, Research Infrastructure

In October, Mr Sach Jayasinghe was appointed as IFE's Director, Research Infrastructure. This new position will lead the strategic development,

management, operation and performance of IFE's research infrastructure portfolio. Sach has had a distinguished career in the university sector, having worked at research organisations in the USA, UK and Australia, and has significant experience in bench research, higher education management, and strategy and policy development.



Institute Manager

In August, Melissa Burton was appointed as the Institute Manager. Melissa has had a distinguished career in the university sector having worked at QUT, University

of Queensland and Griffith University. She has significant experience in policy development, operational management and administration.



Research Theme Leader – Embracing the Digital Age

Professor Marek Kowalkiewicz, PwC Chair in Digital Economy at QUT, was appointed Leader of IFE's Embracing the Digital Age research

theme in 2016. Marek is an academic and industry leader with extensive experience in co-innovating with industry and university partners and delivering innovative products to the market.



Enabling Platform Leader – Manufacturing with Advanced Materials

Associate Professor Anthony O'Mullane became the Leader of IFE's Manufacturing with Advanced

Materials Enabling Platform in 2016. An academic based in the School of Chemistry, Physics and Mechanical Engineering in QUT's Science and Engineering Faculty, Anthony has deep research experience and expertise in materials science and engineering.

Queensland Biofutures Industry Envoy

In December, IFE industrial biotechnology expert Professor Ian O'Hara was appointed Biofutures Industry Envoy by the Queensland Government. In this role, he help the Queensland Government to drive the growth of the biofutures industry in Australia and the Asia-Pacific region. The appointment was made by State Development Minister Dr Anthony Lynham MP.



QUT Professor Ian O'Hara with State Development Minister Dr Anthony Lynham MP

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 Executive Committee

IFE's Governance Committee consists of the Deputy Vice-Chancellor (Research and Commercialisation) and Senior Deputy Vice-Chancellor, executive representatives from the Institute, and appropriate university corporate and faculty executive representatives who oversee the direction, performance, policies and safety of IFE. In 2016, the committee consisted of:

- Professor Arun Sharma – Deputy Vice-Chancellor (Research and Commercialisation) *ex officio* as Chair
- Professor Carol Dickenson – Senior Deputy Vice-Chancellor *ex officio*
- Professor Ian Mackinnon – IFE Executive Director *ex officio* (until June 2016)
- Professor Bronwyn Harch – IFE Deputy Director (Research) *ex officio* (until June 2016); IFE Executive Director *ex officio* (from July 2016)
- Professor Roger Hellens – Acting IFE Deputy Director (Research) *ex officio* (from July to December 2016)
- Professor Gordon Wyeth – Executive Dean, Science & Engineering Faculty *ex officio*
- Professor Mandy Thomas – Executive Dean, to be nominated by Senior Deputy Vice-Chancellor for two years on a rotating basis from non-Science and Engineering Faculty Executive Deans
- Mr Stephen Pincus – Executive Director, Finance & Resource Planning *ex officio* or nominee (until August 2016)
- Mr Graham Fryer – Executive Director, Finance & Resource Planning *ex officio* or nominee (from October 2016).

IFE Executive Team

Day-to-day management of the operations of IFE is the responsibility of the IFE Executive Team, which in 2016 included:

- Professor Ian Mackinnon – Executive Director (Chairperson) *ex officio* (until June 2016)
- Professor Bronwyn Harch – Deputy Director (Research) *ex officio* (until June 2016); Executive Director (Chairperson) *ex officio* (from July 2016)

- Professor Roger Hellens – Acting Deputy Director (Research) *ex officio* (from July to December 2016)
- Professor Sagadevan Mundree – Director, Centre for Tropical Crops and Biocommodities *ex officio*
- Mr Sach Jayasinghe – Director, Research Infrastructure *ex officio*
- Ms Melissa Burton – Institute Manager, *ex officio*
- Dr Mark Gibbs – Director, Knowledge to Innovation *ex officio*
- Mr Tim Campbell – Executive Officer to the IFE Executive Director *ex officio*

Research Leadership Working Group

The IFE Research Leadership Working Group is responsible for leading and facilitating IFE and partner faculty strategic research development across IFE's research themes and enabling platforms. In 2016, the group consisted of:

- Professor Roger Hellens – Acting Deputy Director (Research) *ex officio* as Chair (from July to December 2016)
- Professor Bronwyn Harch – Executive Director *ex officio* (from July to December 2016)
- Dr Mark Gibbs – Director, Knowledge to Innovation *ex officio*
- Associate Professor Robert Speight – Acting Research Theme Leader, Growing the Global Bioeconomy *ex officio* (from July to December 2016)
- Professor Peter Grace – Research Theme Leader, Managing for Resilient Landscapes *ex officio*
- Professor Laurie Buys – Research Theme Leader, Infrastructure for Sustainable Communities *ex officio*
- Professor Marek Kowalkiewicz – Research Theme Leader, Embracing the Digital Age *ex officio*
- Associate Professor Anthony O'Mullane – Enabling Platform Leader, Manufacturing with Advanced Materials *ex officio*
- Professor Tristan Perez – Enabling Platform Leader, IntelliSensing *ex officio*
- Associate Professor Robert Perrons – Enabling Platform Leader, Transforming Innovation Systems *ex officio*.

Health, Safety and Environment (HSE) Committee

The IFE Health, Safety and Environment Committee provides a consultative forum for addressing broad HSE issues across IFE's stakeholders. Membership includes IFE management, Science and Engineering Faculty representatives, HSE professionals, IFE HSE Advisors and IFE staff, including elected Health and Safety Representatives.

The HSE Committee met quarterly in 2016 to consider HSE matters, monitor workplace hazards, make recommendations on improving HSE awareness and skills and assist in development of local HSE policies, procedures and programs.

An important role for the HSE Committee is the review of safety problems, workplace injuries, hazards and near misses. In 2016, reported HSE incidents included 8 workplace injuries, 3 journey-to-work accidents, 8 near misses, 6 safety hazards and 2 illness or health conditions. There was also an environmental incident reported at the Samford Ecological Research Facility related to the discovery of declared pest plants. Most of the work injuries involved hands, fingers, feet or toes being hit by an object; slips, trips or falls; contact with chemicals; or exposure to heat or cold. Most safety issues arose from the use or state of laboratory equipment. As a result of investigations into these incidents, appropriate controls and procedures were developed to mitigate against potential risks associated with these hazards.

The annual HSE Self-Assessment Review, completed on 1 August 2016, allowed IFE to reflect on individual areas' implementation and understanding of applicable QUT policies, procedures and associated work instructions and other documentation as they apply to HSE. The results of this Review showed that staff in the IFE Directorate, Distributed Sites and CTCB are aware of their HSE responsibilities. All hazards, injuries and environment issues are reported on HSE Hub, local areas schedule and conduct regular HSE workplace inspections, and local areas complete and review documented risk assessments for research projects and work activities.

SAI Global conducted an audit of IFE on 20 October 2016, as part of QUT's 2016 Health, Safety and Environment Management System (HSEMS) external audit program. The audit process included interviews with IFE management, laboratory staff and HSE advisors and professionals, as well as a walk through and inspection of our laboratory facilities. The audit highlighted our laboratories' consistent approach to project risk management, comprehensive induction, training and assessment programs, and positive HSE culture. There was a strong uptake of HSE Hub, with all hazards, injuries and environment issues reported, and local areas enthusiastically assisting in scheduling and conducting regular HSE workplace inspections.

Research ethics and integrity

Animal ethics

Many research activities conducted in IFE's laboratories and distributed sites involve the care and use of animals. These activities are monitored by the QUT University Animal Ethics Committee (UAEC) to ensure compliance with the Australian Code for the Care and Use of Animals for Scientific Purposes.

The UAEC inspects IFE's Samford Ecological Research Facility (SERF) and Banyo Pilot Plant aquaculture facility biannually, with the last inspection carried out in 2015 and the next inspection scheduled for 2017. In 2016, IFE provided an interim report to the UAEC on committee-approved undergraduate teaching activities conducted at SERF, which included wildlife surveys of reptiles and mammals, thermal imaging of invasive mammals and animal capture with pitfall traps.

The UAEC also monitors research and teaching activities with insects and marine life that fall outside the scope of the Australian Code. Activities in this category conducted at SERF include studies with ants and other insect populations, as well as acoustic monitoring of birdcalls. Research into fruit fly trap formulations and the sexual selection and courtship behaviour of fruit flies conducted in the insect enclosure facility was also reported.

The impact on wildlife and birds from research use of unmanned aerial vehicles (UAVs) at SERF was a continued focus of the UAEC. Research activities including test flights of UAVs after integration of sensor technologies and the use of UAVs for precision bio-screening in agriculture were approved following careful assessment of any potential effects on wildlife and birds.

Biosafety

Some research activities conducted in IFE's laboratories and distributed sites involve the use of genetically modified (GM) biological material and high-risk non-genetically modified biological material. These activities are 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 approvals from the federal Office of the Gene Technology Regulator (OGTR) to carry out research with GM biological material at designated fields sites and in CTCB laboratories and the Genomics laboratory of IFE's Central Analytical Research Facility. The CTCB laboratories and the CARF Genomics laboratory are also approved quarantine facilities under an agreement with the Australian Department of Agriculture and Water Resources.

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

Human ethics

For research projects involving human subjects, IFE researchers utilise the ethics approval processes through QUT's faculties and the central Office of Research Ethics and Integrity.

Financial report

The table below provides a summary of transactions on IFE-related accounts for the period 2013–2016. 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	2013*	2014	2015	2016
	\$ '000s	\$ '000s	\$ '000s	\$ '000s
Research				
Competitive Grants+	1486	12483	7438	6,309
University Distributions	-	1784	1843	1,901
Commercial	2289	5979	7664	5,690
Sub-total	3775	20247	16945	13,900
Operations				
University Distributions	10329	13991	15446	14,004
Other	804	1076	1630	649
Sub-total	11133	15067	17076	14,654
Total Revenue	14908	35314	34020	28,555
Expenses				
	\$'000s	\$'000s	\$'000s	\$'000s
Research				
Employee Costs	1636	8429	8472	8,130
Non-Employee Costs	937	6740	6824	5,365
Sub-total	2573	15170	15296	13,495
Operations				
Employee Costs	6800	12158	13684	14,678
Non-Employee Costs	2837	3912	5208	5,550
Sub-total	9638	16070	18892	20,227
Total Expenditure	12211	31239	34188	33,723
Opening Retained Funds	2130	4082	12831	13,408
Profit/(Loss)	2697	4075	(167)	(5,167)
Retained Funds Transfer	45	4162	146	(730)
Capital Acquisitions++	991	675	1053	494
Depreciation	201	1188	1650	1,480
Closing Retained Funds	4082	12831	13407	8,497

* 2013 does not include the Centre for Tropical Crops and Biocommodities.

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

++ Does not include Major Equipment (SMEP).



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