LEARNING AND
BIG SOLUTIONS (LABS)

Snapshots from the QUT
Science & Engineering Faculty

THE LABS

QUT

2017 | 2018

BEAUTIFUL PLANT PHOTO
REVEALS SCIENTIFIC SECRETS

The stunning image of ultraviolet-drenched leaves being slowly infected by a fluorescent-stained virus is a symbol of the modern science fight against plant diseases that threaten the world's food crops.

The power of fluorescent proteins, by QUT international PhD student Steven Charlesworth won the 2017 QUT Science in Focus Image Competition.

The UV light shows Potato virus X tagged with green fluorescent protein (GFP) making its way through the leaves.

The fluorescent protein has existed in the *Aequorea Victoria* jellyfish for 160 million years and cloned in the 1990s, making it readily available for laboratories around the world.

It has helped revolutionise research in many areas of biology because it enables real-time monitoring of a range of phenomena in living cells and organisms.

Some areas include gene expression, protein localisation and dynamics, cell division and intracellular transport pathways.

Mr Charlesworth works with Professor Peter Waterhouse, a world-leading plant virologist and geneticist based at QUT's Centre for Tropical Crops and Biocommodities.

His PhD research focuses on ways to fight plant diseases that threaten the world's food crops.

KEY CONTACTS

**Professor Peter Waterhouse,
Australian Laureate Fellow**
peter.waterhouse@qut.edu.au

Cover image: 'The power of fluorescent proteins', by Steven Charlesworth.

CONTENTS

CONTENTS

Professor Gordon Wyeth
Executive Dean
QUT Science and Engineering Faculty

Vision and goals

Our mission is to be the STEM partner of choice for education and research. Quite simply, we want to change the world.

We seek to deliver our vision in four ways:

- **creating** highly valued STEM learning experiences

- **building** authentic assessment based on real-world STEM practice

- **researching** at the frontiers of STEM knowledge

- **delivering** innovative STEM solutions that have real-world impact.

The new global economy is growing, led by smart companies with innovative technologies and a solid foundation in science, technology, engineering and maths (STEM).

These disciplines power an engine room of growth, delivering innovative solutions, creating new sources of wealth and bringing new skills to our workforce.

It's an exciting time and the Science and Engineering Faculty at QUT is perfectly placed to bring new skills and solutions to our students, industry and government.

Teaching quality is a hallmark of the education we provide and our reputation for STEM education continues to grow.

Quality indicators for learning and teaching performance show that our students rate their experience in STEM courses at QUT as being among the very best in Australia.

This sentiment is also reflected among our peers with Distinguished Professor Peter Corke named as Australian University Teacher of the Year.

In 2018, we experienced the highest demand on record for our courses with almost 12,000 students enrolled.

Our online presence continues to break new ground too, with the QUT Robot Academy achieving more than 300,000 lesson views in its first 12 months.

Over the last year we delivered hands-on STEM programs to almost 30,000 Queensland primary and high school students either on QUT campuses, within their schools through our Widening Participation Program, or through our community events.

Through our efforts to increase student aspiration towards STEM studies, we are building our national literacy in these fields and ensuring our future participation in industry, innovation and discovery through research.

Real-world research impact is built on academic quality.

Ours is listed among the best in the world. Overall, the volume of research is 'boutique' compared with that of global leaders but the quality is high with our papers among the most highly cited in our areas of strength.

I invite you to learn about some of our activities through The LABS, our annual publication which showcases research and education impact across so many sectors of our society.

Transport, food production, information technology, healthcare, nutrition, defence, environment and manufacturing all benefit from research by the Science and Engineering Faculty in partnership with QUT's flagship institutes: the Institute for Future Environments and the Institute of Health and Biomedical Innovation.

I'm delighted to bring you this issue of The LABS and hope it gives you some insight into how we are changing the world through education and research.

AUSTRALIA'S FIRST FEMALE CHEMISTRY PROFESSOR JOINS QUT AS VICE-CHANCELLOR

Australia's first female chemistry professor, Margaret Sheil AO, joined QUT in February 2018 as the university's Vice-Chancellor, succeeding Professor Peter Coaldrake AO, who left the university after 15 years of distinguished service at the end of 2017.

Professor Sheil is an established university leader, having a successful academic career at the University of Wollongong prior to her appointment as the Chief Executive Officer of the Australian Research Council (ARC) from 2007 to 2012, a role that saw her lead the development of the Excellence in Research for Australia (ERA) evaluation of Australian university research and the implementation of a range of initiatives to support women, early career and Indigenous researchers.

She was most recently Provost, deputy to the Vice-Chancellor and the Chief Academic Officer at the University of Melbourne where she championed online strategy and other curriculum reform, business transformation, and the recruitment and development of academic leaders.

A highly respected chemist, she is a Fellow of the Australian and New Zealand Society for Mass Spectrometry; the Royal Australian Chemical Institute; and the Australian Academy of Technological Sciences and Engineering.

In 2016, Professor Sheil joined the ATSE Board and the Board of the Australian Nuclear Science and Technology Organisation.

Professor Sheil has been a member of the Prime Minister's Science, Engineering and Innovation Council and the Cooperative Research Centres Committee. The Royal Australian Chemical Institute's Margaret Sheil Leadership Award was established in recognition of her work. And in 2017 she was awarded an Order of Australia for her services to science and education.

Professor Sheil holds a BSc (Hons) in Pure and Applied Chemistry and a PhD in Physical Chemistry from the University of New South Wales.

QUT ranked among the top 20 young universities in the world in two international rankings – the Times Higher Education (THE) Young University Rankings 2018 and the 2019 QS Top 50 Under 50.

QUT also joined the top 20 in the UK-based THE '150 Under 50', which showcases young universities that achieved great research and teaching successes.

These placements consistently made QUT Queensland's top university under 50 years of age in 2018. At 19th, the QS rankings place QUT third among Australian universities.

First to host the Young Universities Summit

QUT hosted the Times Higher Education (THE) Young Universities Summit 5-7 April 2017, the first time the event was held in the Southern Hemisphere.

The Brisbane summit focused on ways younger universities have risen in prominence and challenged the traditional order of higher education.

Themes explored diversity in leadership, new models of collaboration, integrating STEM and creativity, and `real world' futures.

QUT hosted the Times Higher Education 2017 Young Universities Summit and presenters from around the world including Professor Carla E Brodley from Northeastern University. Photo: Roger Philips/QUT Marketing & Communication.
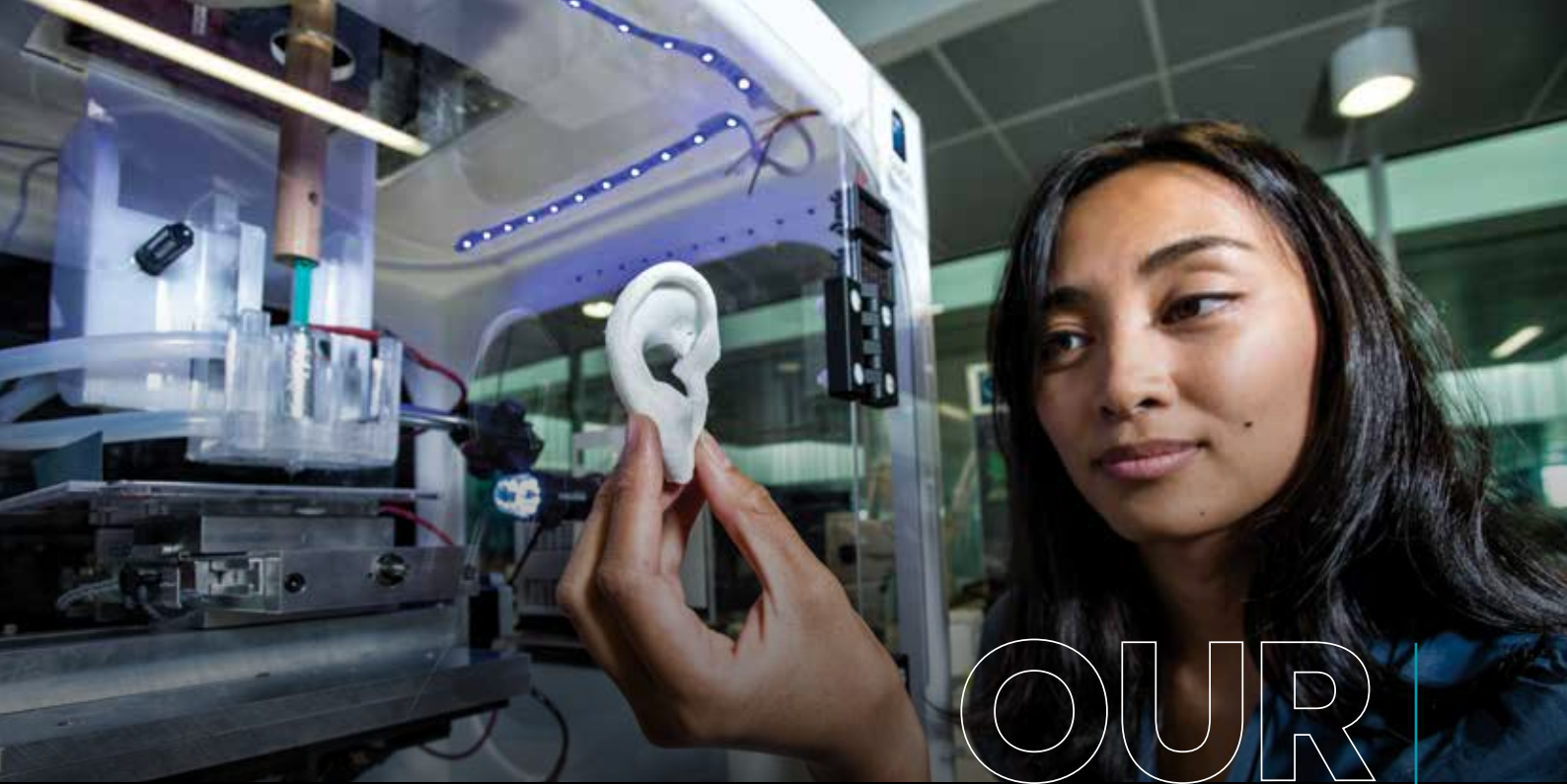
OUR
APPROACH

Collaborative research with real impact.

Succeeding in a competitive environment

7%
Category 4

44%
Category 1

24%
Category 3

%

25%
Category 2
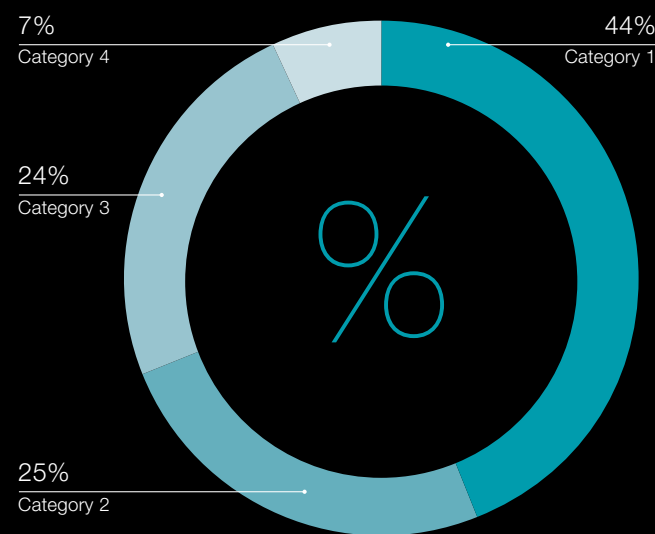
In 2017, the QUT Science and Engineering Faculty secured more than $40 million in research funding.

The faculty focuses on high-quality fundamental and applied research across the sciences, technology, engineering, mathematics, medical and urban development fields.

■ **Category 1:** Australian Competitive Grants

■ **Category 2:** Public Sector Funding

■ **Category 3:** Industry and Other Funding

■ **Category 4:** Cooperative Research Centre Funding

FOOD AGILITY |

A $210 million Food Agility Cooperative Research Centre (CRC) based at QUT aims to make the Australian agrifood sector more globally competitive and sustainable by helping producers with innovation and technology.

Over the next 10 years, Food Agility will lead a digital revolution in food production and supply through brokered research and data sharing in trusted networks.

It will also focus on education that increases digital literacy and builds a future workforce in the agrifood sector.

Launched in 2017, the CRC received $50 million from the Australian Government and $160 million from 54 partners in private business and universities - including QUT, University of Technology Sydney and Curtin University.

www.foodagility.com

KEY CONTACT

Camilla Roberts
Food Agility Innovation Broker (Queensland)
camilla.roberts@foodagility.com

The QUT-based Food Agility CRC is a partner in BeefLedger, a blockchain technology project to track beef from paddock to plate.

iMOVE FOR BETTER TRANSPORT SYSTEMS

QUT joined the iMOVE Collaborative Research Centre (CRC) to improve Australia's transport systems and prepare it for integrated autonomous vehicles.

With $55 million in Australian Government funding over 10 years, iMOVE will develop technology outcomes that benefit all Australians through its 46 partners among leading government, industry and research organisations.

iMOVE goals:

- reduce road congestion, fuel use, emissions, accidents and fatalities
- improve freight co-ordination
- improve productivity and international competitiveness
- improve lifestyle and wellbeing.

iMove aims to deliver the technical infrastructure, data frameworks, models and tools to support Australia's adoption of increasingly sophisticated transport networks.

QUT contributes to iMOVE projects through its research expertise in road safety, smart transport, regional and urban planning, digital media and design.

Dr Marc Miska from the QUT Civil Engineering and Built Environment School is a researcher with iMove and said outcomes would shape the future.

"Connected and automated vehicles will be part of the future, and now is the time to get ready for it. iMove will help industry and government to better understand what is necessary to be ready in terms of infrastructure, vehicles and people," Dr Miska said.

"Mobility as a service is a concept that yet has to be shaped into a form that will be accepted by the end, user. iMove is leading the way to shape Mobility as a Service for the Australian context."

"Freight is often under-represented in research. iMove puts freight in the spotlight and opens up doors for new concepts in which every truck, every delivery van and every driver become part of a connected data platform."

imovecrc.com

KEY CONTACT

Dr Marc Miska
marc.miska@qut.edu.au

UPGRADING AGEING RAIL INFRASTRUCTURE

KEY CONTACTS

Professor David Thambiratnam
d.thambiratnam@qut.edu.au

Professor Manicka Dhanasekar
m.dhanasekar@qut.edu.au

OTHER PROGRAM PARTNERS

- Australian Centre for Rail Innovation
- SMEC
- Metro Trains Melbourne
- CREEC
- Transport for New South Wales

A new training centre will equip the next generation of engineers with knowledge and skills needed to upgrade Australia's rail network.

The Australian rail network is the sixth largest in the world with 38,500km of track carrying more than 1 billion tonnes of freight and 850 million passenger trips annually.

It is an essential part of the national transport infrastructure.

The Industrial Transformation Training Centre for Advanced Technologies in Rail Track Infrastructure announced in 2017 received $3.9 million in Australian Research Council funding over four years and $1.8 million from industry partner organisations.

QUT professors David Thambiratnam and Manicka Dhanasekar from the School of Civil Engineering and Built Environment joined other researchers collaborating through the centre, which is led by the University of Wollongong.

Working with the Australian Centre for Rail Innovation, QUT chief investigators will focus on innovative design and construction technologies to accommodate increased axle loads and train speeds for heavy haul tracks whilst improving safety and stability.

Researchers will also look for new manufacturing approaches for intelligent vibratory rollers with the aim of pioneering new methods of analysis for track design, tackling train/track interaction problems including excessive noise and vibration, passenger comfort, ballast degradation and progressive track misalignment.

railresearch.org.au

ADDITIVE BIOMANUFACTURING

AUSTRALIA–WIDE RESPONSE TO CYBER THREATS

The Australian Research Council (ARC) Industrial Transformation Training Centre in Additive Biomanufacturing (ABM) focuses on advancing ABM technology, materials and clinical translation.

- High throughput ABM technology platforms.
- Development, characterisation and industrial upscaling of bioinks.
- Innovation approaches for clinical applications.

Based at the QUT Institute of Health and Biomedical Innovation, the centre is a collaboration between five Australian universities, the Shanghai Institute of Ceramics, St Vincent's Hospital in Melbourne and medical industry partners.

University collaborators include QUT, University of Wollongong, RMIT, Deakin University and the University of Melbourne.

additivebiomanufacturing.org

Students with the ARC Industrial Transformation Training Centre in ABM (from left) Jose Malayil, Onur Bas, Ross Kent, Madeline Hintz, Maria Flandes Iparraguirre, Felix Wunner, Navid Toosisaidy, Joachim Maartens, Quentin Peiffer, Pawel Mieszczanek, Svenja Kratz and Madison Ainsworth (middle front). Credit QUT Media.

KEY CONTACT

Professor Colin Fidge
c.fidge@qut.edu.au

QUT is taking a leading research role in developing Australia's critical infrastructure in cyber security as a partner in the $140 million Cyber Security Cooperative Research Centre (CRC), launched in April 2018.

The centre aims to grow national capability in cyber security research, development and commercialisation, with an initial focus on cyber security in critical infrastructure and cyber security as a service.

QUT will lead infrastructure development through two key research themes:

- resilient systems (Brisbane-based)
- network forensics and responses to emerging threats (Perth-based).

The Cyber Security CRC leveraged $84.4 million worth of contributions from 25 industry, state government, university and research participants, in addition to $50 million from the Australian Government over seven years and $5.6 million from the Western Australian Government over seven years, totalling $140 million.

QUT joins other research partners including CRC host Edith Cowan University, Adelaide University, Deakin University, Charles Sturt University, University of NSW, and Data61 (a division of CSIRO).

Industry partners include CISCO Systems Australia Pty Ltd, Singtel Optus Pty Ltd, Jemena Ltd, ActewAGL Distribution, TATA Consultancy Services, Datacom Technical Security Services, PEN10 Services Pty Ltd, Quintessencelabs Pty Ltd, and AARNet Pty Ltd.

The Cyber Security CRC will also work closely with the government's Cyber Security Growth Network (AustCyber) to help deliver innovation in cyber security and to foster a strong national cyber security sector.

Cyber security experts are encouraged to join the national effort to advance and protect Australia's online interests through postdoctoral research with the centre partners.

BIOMEDICAL ENGINEERING

A better healthcare future.

Australian researchers are exploring additive biomanufacturing (ABM) to devise new ways to customise treatments for patients with challenging problems ranging from large bone defects to deafness.

ABM refers to 3D printing with biological components.

Directed by QUT Distinguished Professor Dietmar W. Hutmacher, research teams at the Australian Research Council (ARC) Industrial Transformation Training Centre in ABM include biomedical engineers, biochemists, surgeons, and a lawyer working on every aspect of this field of medicine.

PhD candidates and post-doctoral researchers work with an industry partner and academic expert to bring findings from 'bench to bedside' quickly.

Breaking new ground

- Design and manufacture of 3D printers based on the concept of melt electrospinning writing (MEW) to enable printing at a finer scale than previously achieved – down to 0.01mm. These can be precisely tailored for a variety of biomedical applications such as heart valves, blood vessels, nerve guides and bone scaffolds.

- Development of advanced bioinks that allow 3D-printed cells and fabrication of 3D models for cancer research, developed and manufactured by spin-off company Gelomics.

On the brink of patient-specific outcomes

- A hand-held 'bio pen', fed with bioink that will allow surgeons to 3D-print patient-specific cartilage cells on to knee and hip joints to repair and replace cartilage.

- 3D-printed synthetic blood vessels, nerves, ligaments and tendons to enable surgeons to increase their skill and speed making small sutures and test the quality of their suturing by measuring the burst strength and water leakage.

- Patient-specific cancer therapy using 3D-printed hydrogels to model each patient's tumours to test for the most effective drug for that particular patient.

Personalised breast cancer treatment

- Bioink software and hardware could enable surgeons to use patient-specific, 3D-printed implants containing anti-cancer chemotherapy for posy-mastectomy breast cancer patients.

- A 3D printed biodegradable scaffold combines chemotherapy and the patient's own cells, growth factor, and regenerative proteins isolated from the patient's blood.

- The research will enable individualised drug therapies so patients receive the right amount and combination of drugs needed to kill off potential cancer cells in remaining tissue, meaning lower m and fewer doses of chemotherapy and lower side effects.

BioPen UV light is one of the technologies already developed by research teams at the QUT-based ARC Industrial Transformation Training Centre in ABM.
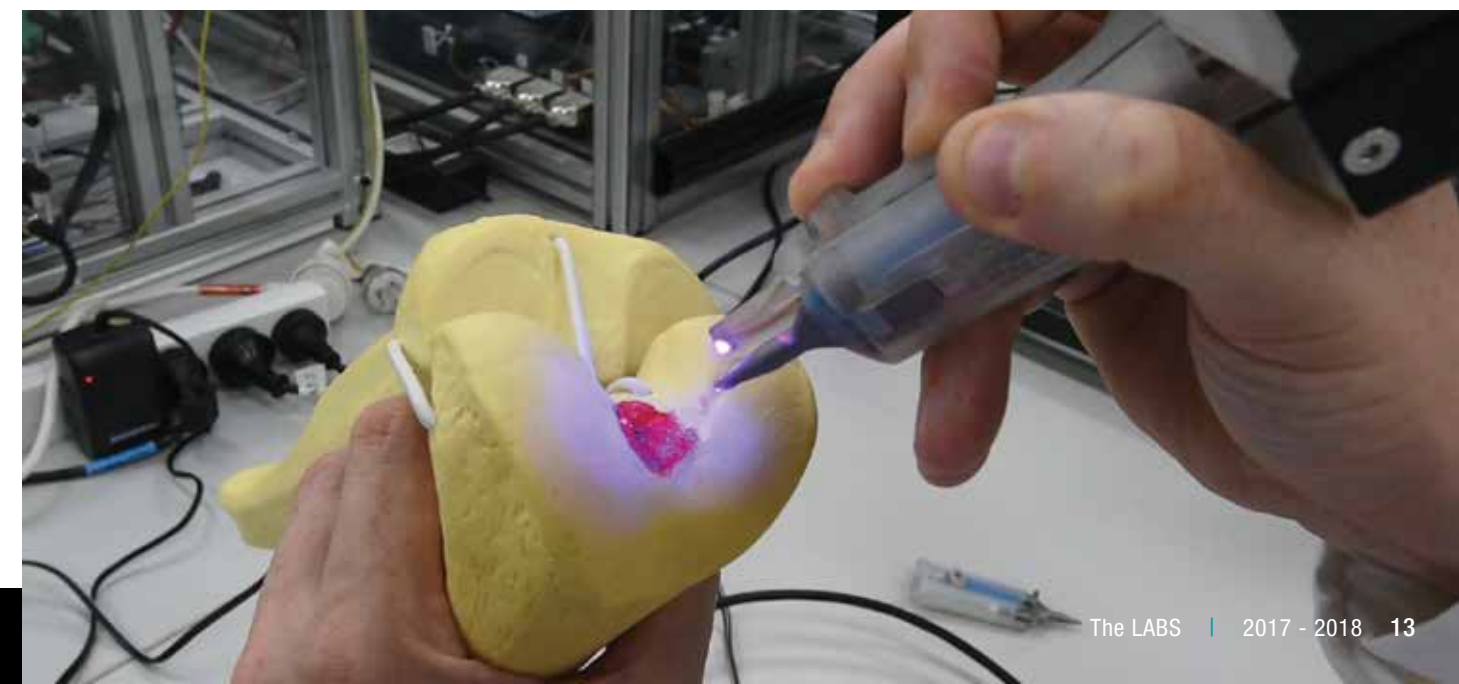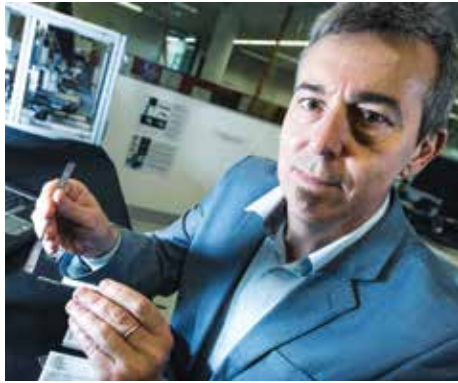
The project is directed by QUT Distinguished Professor Dietmar W. Hutmacher and funded through the Queensland Government's Advance Queensland program.

World-first shin bone implant

QUT research and technology is behind the first ever 3D-printed shin bone implant in a young Gold Coast man, replacing bone lost through an infection.

Researchers developed a computer model and 3D printed a series of physical models of the large bone defect from CT scans of the patient's tibia bone, then designed a patient-specific implant in the form of a highly porous scaffold to guide the regeneration of new bone.

The QUT team used a 3D printer from the Queensland-based company 3D Industries to print the models.

The final scaffold design was sent to Osteopore International, which has a 10-year clinical track record for FDA-approved and CE-marked biodegradable scaffolds.

The technology enables customised, 3D-printed scaffolds which are slowly resorbed by the patient's body after guiding the new bone formation.

The research team included Dr Marie-Luise Wille, Dr Nathan Castro and PhD student Sebastian Eggert, who worked closely with Dr Michael Wagels, the Princess Alexandra plastic surgeon who performed the surgery.

Training surgeons

Professor Hutmacher and Dr Wagels started an innovative PhD training program partially funded by the PA Research Foundation in which young surgeons train and perform cutting-edge research in 3D printing medicine.

Professor Hutmacher said their vision was to deliver an exceptionally talented group of entrepreneurs who will start high-impact companies.

"They will have their roots in globally competitive fundamental and applied STEM research as well as in manufacturing innovation and new medical devices."

KEY CONTACT

**Distinguished Professor
Dietmar W. Hutmacher**
dietmar.hutmacher@qut.edu.au

Hydrogels that reproduce aspects of the liver, kidneys or heart muscles could be used to test and identify novel pharmaceutical molecules for drug development.

KEY CONTACTS
Associate Professor Tim Dargaville
t.dargaville@qut.edu.au

Dr Aurelien Forget
aurelien.forget@qut.edu.au

Hydrogels that reproduce aspects of the liver, kidneys or heart muscles could be used to test and identify novel pharmaceutical molecules for drug development.

Created by Dr Aurelien Forget in collaboration with Associate Professor Tim Dargaville, new materials extracted from marine algae are used to 3D-bioprint human stem cells in distinct environments, and without harming cells through heat and mechanical printing processes.

The new technique is used to organise cells and other biological materials into 3D hydrogels.

The 3D printing technology will provide more complex 3D models that reproduce aspects of the liver, kidneys or heart muscles, suitable for testing and identifying novel pharmaceutical molecules.

Only 10-15 per cent of drugs tested in human trials make it to market, mainly due to poor efficacy in humans despite promising results in animals.

Bringing a new drug to market using current methods costs an estimated US$2.5 billion, and can take more than 10 years from start to finish.

Multinational pharmaceutical companies are already using these models, and funding agencies in Australia and globally are supporting projects for drug development using bioprinted tissues.

The 3D bioprinting technology also marks another step towards printing complex living structures.

Processes are advanced for relatively simple tissues like skin, but the next phase of technology requires the incorporation of nerves, blood vessels and lymphatic vessels that integrate with the host system to create transplantable whole organs such as kidneys, lungs, hearts or livers.

The development of 3D-printed biological tissues for organ replacement would ultimately offer options to some 1,500 patients on the organ receiver waiting list every year in Australia.

INJECTION A WELCOME RELIEF FOR ARTHRITIS SUFFERERS

KEY CONTACT

Dr Indira Prasadam
i.prasadam@qut.edu.au

Dr Indira Prasadam and her team have discovered a less invasive and more effective way to treat pain and mobility issues in osteoarthritis (OA) sufferers.

The team developed an alternative therapy that can be injected using a standard arthroscopic device to re-surface damaged knee joints in just 30 minutes.

"We believe our product will significantly reduce OA-associated Australian healthcare costs and enhance quality of life for many ageing Australians," Dr Prasadam said.

OA develops when injury or wear and tear creates chronic and painful defects in articular cartilage, with ageing, obesity, sports injuries and inflammation all factors.

The product Dr Prasadam's team developed is injected to fill the damaged area, relieving patients of pain.

It includes a gel that creates synthetic cartilage to support joint function.

Current OA treatment costs the Australian healthcare system $2.3 billion in 2007.

It is Australia's most common cause of pain and disability, affecting 18 per cent of the population.

OA incidence is expected to triple by 2030.

Dr Prasadam said joint replacement surgery was the only current treatment for severe OA patients, and that available implants had a limited lifespan of approximately 5-10 years.

"Our treatment can be used in any joint affected by OA, such as hips, knees, shoulders, fingers or toes," she said.

FEEDING THE WORLD

Improving nutrition, resilience and yield.

Top: Comparing orange pro-vitamin A rich bananas with non-modified Cavendish bananas.

PANAMA DISEASE–RESISTANT BANANAS

KEY CONTACT

Distinguished Professor James Dale AO
j.dale@qut.edu.au

QUT researchers developed and grew modified Cavendish bananas resistant to the devastating soil-borne fungus Fusarium wilt tropical race 4 (TR4), also known as Panama disease.

Conducted in heavily TR4-infested soil, their world-first field trial resulted in one completely TR4 free Cavendish line, which had been transformed with a gene taken from a wild banana, and three others that showed robust resistance.

By contrast, 67-100 per cent of control banana plants were either dead or TR4-infected after three years, including a Giant Cavendish variant 218 generated through tissue culturing in Taiwan and reported to be TR4-tolerant.

Distinguished Professor James Dale AO from the QUT Centre for Tropical Crops and Biocommodities led field trials and said TR4 was a huge problem.

"TR4 can remain in the soil for more than 40 years and there is no effective chemical control. It is a huge problem. It has devastated Cavendish plantations in many parts of the world and it is spreading rapidly across Asia," Professor Dale said.

Researchers modified the Cavendish Grand Nain with the RGA2 gene, taken from the TR4-resistant wild, south-east Asian banana subspecies, *Musa acuminata ssp malaccensis*.

Professor Dale said the correlation demonstrated between the RGA2 gene activity and TR4 resistance opened up new research.

"We've found that the RGA2 gene occurs naturally in Cavendish – it just isn't very active.

"We are aiming to find a way to switch that gene on in the Cavendish through gene editing.

"We're also looking at as many genes as possible in the wild banana and screening them to identify other resistance genes, not only for resistance to TR4 but to other diseases."

Top: QUT Distinguished Professor James Dale and his teams are developing the world's first Cavendish banana resistant to Panama disease.

QUT DEVELOPS GOLDEN BANANAS HIGH IN PRO-VITAMIN A

QUT is conducting field trials of pro-vitamin A enhanced bananas in Uganda, where the fruit is a major staple food.

World-first QUT research produced a golden-fleshed banana, rich in pro-vitamin A.

The decade-long genetic modification project, led by Distinguished Professor James Dale AO, successfully identified and selected banana genes that could be used to enhance pro-vitamin A in banana fruit.

The researchers are working to improve the nutritional content of bananas in Uganda, where they are the major staple food.

Professor Dale said an estimated 650,000-700,000 children worldwide die from pro-vitamin A deficiency each year, a further several hundred thousand going blind.

"Achieving these scientific results, along with their publication, is a major milestone in our quest to deliver a more nutritional diet to some of the poorest subsistence communities in Africa," Professor Dale said.

"What we've done is take a gene from a banana that originated in Papua New Guinea and is naturally very high in pro-vitamin A but has small bunches, and inserted it into a Cavendish banana.

"Over the years, we've been able to develop a banana that has achieved excellent pro-vitamin A levels, hence the golden-orange rather than cream-coloured flesh.

"These elite genes have been sent to Uganda in test tubes where they have been inserted into Ugandan bananas for field trials there."

Professor Dale said young Ugandan students, who came to QUT to undertake their studies, had now completed their PhDs and were overseeing the research and field trials in Uganda.

The project was funded with almost $10 million from the Bill & Melinda Gates Foundation and the UK Government's Department for International Development.

ROBOTIC ROADMAP TO THE FOURTH INDUSTRIAL REVOLUTION

KEY CONTACT

Dr Sue Keay
sue.keay@qut.edu.au

Roadmap Recommendations taken from A Robotics Roadmap for Australia 2018, Australian Centre for Robotic Vision.

The QUT-headquartered Australian Centre for Robotic Vision delivered the country's first Robotics Roadmap to guide and grow robotics and automation in Australia, with new research revealing the industry is now worth more than $12 billion to the nation annually.

The centre's Chief Operating Officer, QUT's Dr Sue Keay, said *A Robotics Roadmap for Australia* came at a critical time in the industry's development.

"Robotic technologies are at the heart of the fourth industrial revolution," Dr Keay said.

"*A Robotics Roadmap for Australia* sets out where we are now, where we want to be and, importantly, the options for getting us there.

"Australia has an impressive robotics history – we were the first country in the world to automate our ports, our mine sites have deployed self-driving haulage vehicles, and we are using robots to protect the reef.

"But to continue to develop, and to secure our future, the industry requires a collaborative, multi-sector approach. We firmly believe this roadmap provides the foundation to achieve that.

"Through a series of workshops and submissions, we have heard directly from decision makers in sectors including resources, manufacturing, agriculture, defence, healthcare, services, and the built and natural environment.

"That has allowed us to learn more about how the robotics industry is growing in sectors of national significance, as well as identifying the future needs and possibilities for the technology," she said.

Roadmap Recommendations

Industry	**Education**	**Government**	**R&D**	**Culture**
Ensure Australia's ongoing prosperity by stimulating formation of new hi-tech firms, encouraging global tech giants to invest in Australia, and reskilling Australian workers	Equip all Australians with Industry 4.0 relevant skills	Lead the region in catalysing robotics activity by setting ethical, legal, regulatory and standards frameworks, adopting robotics in government services	Develop clusters of robotics activity, encourage VC investment, develop pathways to commercialisation and encourage application of the social sciences	Support an entrepreneurial culture around Australia's niche robotics capability and harness the nation's imagination through aspirational goals solving Australian challenges

TRANSFORMING INDUSTRIES

Robotics and computer vision.

Top: The robot doctor will see you now: evolution of robotic vision. Dr Anjali Jaiprakash spoke at TEDxSydney in June 2018. Credit: Australian Centre for Robotic Vision.

A Robotics Roadmap for Australia 2018

Jobs of the future

Whilst there have been concerns that increased automation would take away jobs, Dr Keay said the roadmap showed that did not have to be the case.

"Our continued standard of living depends on us improving productivity by 2.5 per cent each year and to achieve that we must look towards automation," she said.

"By building a stronger robotics industry in Australia, we can prepare the next generation for the jobs of the future, upskill our current workforce and re-shore jobs back to Australia.

"We envisage a future for Australia where robots do dull, dirty and dangerous tasks, allowing workers to enjoy more satisfying, safe and creative employment."

Dr Keay said there was an opportunity for Australia to become a testbed for robotics technology by leading the world in ethical, legal and standards frameworks.

"We urge the government to lead the region in catalysing robotics activity by establishing these frameworks and adopting robotics in government services," she said.

"But that is not all we must do. We must also support an entrepreneurial culture and harness the nation's imagination to solve challenges in our own backyard – and we must encourage venture capital investment in our technology and develop pathways to commercialisation.

A Robotics Roadmap for Australia is available for download at **www.roboticsroadmapau.org**

Below: Dr Sue Keay, Chief Operating Officer of the QUT-based Australian Centre for Robotic Vision (right) with Senator Jane Hume, Chair of Economics Legislation Committee at the launch of the roadmap. Credit: Australian Centre for Robotic Vision.

SURGICAL PRECISION USING ROBOTICS

KEY CONTACT

**Professor Ross Crawford,
Chair in Orthopaedic Research**
r.crawford@qut.edu.au

Top: A QUT-developed medical robotic system enabling 3D vision of keyhole procedures combines stereo cameras, 4D ultrasound sensing and artificial intelligence. Credit: Ben O'Sullivan.

Surgeons could track the position of soft tissue during keyhole procedures in real-time and in 3D using a new robotic imaging system being developed at QUT.

Unlike current medical imaging tools, which can only track the position of bone and medical tools, the new system combines state-of-the-art miniaturised stereo cameras, 4D ultrasound sensing and artificial intelligence.

Orthopaedic surgeon and researcher Professor Ross Crawford leads the project through QUT's Institute of Health and Biomedical Innovation and the Australian Centre for Robotic Vision, headquartered at QUT.

"Patients recover from keyhole surgeries more quickly than open surgeries because the surgery is minimally invasive," Professor Crawford said.

"Working with a dynamic 3D model rather than a flat image on a screen is a real game changer in terms of accuracy in keyhole surgeries – it will give the surgeon precise knowledge of how deep the objects in the surgical site really are.

"We're building the system for knee arthroscopy surgeries first but we're confident this is a system that can be easily adapted for other surgeries – hip, shoulder, abdomen, heart."

The project received $996,000 from the Australian Government through the Australia-India Strategic Research Fund.

Collaborators include QUT, Indian Institute of Technology-Madras, All India Institute of Medical Sciences-Delhi, University of Adelaide and Perfint Healthcare, Indian Institute of Technology-Kharagpur and Manipal University.

NEW SYSTEM FOR TRACKING ASSETS IN UNDERGROUND MINES

KEY CONTACT

Professor Michael Milford
michael.milford@qut.edu.au

A camera-only positioning system could track assets in underground mines without the need for major infrastructure.

Top (left to right): Robotic vision researchers Dr Fan Zeng, Dr Adam Jacobson, Professor Michael Milford, Associate Professor Thierry Peynot.

Safety, efficiency and increasing competitiveness is driving mining companies to advance technologies that enable automation.

QUT, Mining3 and Caterpillar are collaborating to deliver the equivalent of GPS to underground mining, without the need to install significant infrastructure throughout the mine.

QUT Professor Michael Milford and his team of robotics researchers are developing new technology that allows underground mining vehicles to navigate autonomously through dust, camera blur and bad lighting.

The research team is working on an 'approximate camera-only' positioning system for tracking the location of mobile assets in an underground mine, as well as a more accurate positioning module to help facilitate autonomous operation underground.

Using mathematics and biologically inspired algorithms, the technology uses vehicle-mounted cameras to track the location of the vehicle in underground tunnels to within metres.

The three-year project began in 2017 with funding from the Queensland Government's Advance Queensland Innovation Partnerships program.

KEY CONTACT

Belinda Ward
br.ward@qut.edu.au

QUT project leader Belinda Ward, with Pepper. Credit: Anthony Weate, QUT.

QUT became Australia's first university to use Pepper specifically for a social robotics research platform, complementing the Queensland Government's strategy to explore the potential for humanoid robots.

Created by SoftBank Robotics, Pepper is promoted as the world's first personal humanoid robot that can recognise emotions.

Pepper also mimics human behaviours such as following the conversation around it by looking at whomever is talking.

QUT project leader Belinda Ward said social robots like Pepper have real potential to change society.

"What we learn from human-computer interactions with Pepper will inform the next generation of service robots, building an effective social component into their task-oriented programming."

The $1.5 million social robotics research program is funded by the Queensland Government's Advance Queensland initiative and involves collaborators ST Solutions Australia (STSA), SoftBank Corp's subsidiary, and the Australian Centre for Robotic Vision.

With the funding, the project team is exploring the different applications of social robots across a range of settings and conditions, and their effectiveness in each.

Researchers are also working with STSA to improve Pepper's vision and navigation systems, making the robot even more versatile in the future.

AUSTRALIA'S FIRST ACCELERATOR DEDICATED TO ROBOTS

KEY CONTACT

Tim McLennen, CEO, QUT bluebox,
enquiries@qutbluebox.com.au

The Robotics Accelerator, a first for Australia, brings together entrepreneurial teams, innovative hardware technologies and world-class business mentoring.

QUT's innovation and commercialisation arm, QUT bluebox, has partnered with the Queensland Government and ST Solutions Australia to deliver the Robotics Accelerator program at The Precinct, Queensland's innovation and startup centre in Fortitude Valley.

The program aims to fast-track development of the next generation of startup founders to drive robotics and other hardware solutions across a range of industries.

www.qutbluebox.com.au/robotics

ROBOTS THAT SEE FOR AUSSIE SMEs

KEY CONTACT

Professor Jonathan Roberts
jonathan.roberts@qut.edu.au

QUT is helping Brisbane's UAP design an agile, flexible manufacturing robot.

Below (left to right): Matt Tobin, UAP founder and managing director; Bruce Blundell, Design Documentation Lead at UAP; Dr Glenda Caldwell, QUT Design (architecture); Dr Jared Donovan, QUT Design (interaction).

Robots will revolutionise manufacturing among Australia's small-to-medium-sized enterprises (SMEs) – creating more jobs locally.

Current manufacturing robots are inflexible machines that perform one pre-programmed task repeatedly.

QUT, Urban Art Projects (UAP) and the Innovative Manufacturing Cooperative Research Centre (IMCRC) are creating the first in a new wave of agile, adaptable robots that can see what they are working on and make on-the-fly decisions.

QUT design and robotics experts are training robots at Brisbane's UAP to create large-scale, bespoke public art pieces that, until now, were impossible to produce economically.

It is the start of an $8 million design robotics research project to develop vision-enabled robots that SMEs can use easily to make high-value products, open export opportunities and create more jobs in Australia.

"We build big, one-off, high-quality art pieces for organisations around the world," said UAP founder and managing director Matthew Tobin, a QUT alumnus.

"While our team certainly has the skills to deliver these artworks, the cost of making these increasingly complex pieces is becoming prohibitive, particularly given the rising manufacturing costs in China.

"Having a robot on site with the intelligence to see what it's working on and make adjustments on the fly will allow us to manufacture more of the pieces here in Brisbane, broaden the scope of designs we can achieve and employ more designers and technical staff."

QUT is leading the five-year design robotics project in partnership with UAP, the newly-established IMCRC, RMIT and construction company Laing O'Rourke.

NATIONAL ROBOTICS DEFENCE RESEARCH BASED IN QUEENSLAND

A new $50 million Defence Cooperative Research Centre for Trusted Autonomous Systems (DCRC) will investigate how autonomous systems, robotics and artificial intelligence can play a key role in Australia's future military capabilities.

In December 2017 the Minister for Defence Industry, Hon Christopher Pyne MP, confirmed the DCRC would be located in Queensland and funded over seven years.

The Office of the Queensland Chief Scientist led the successful bid to attract the research facility to Queensland, in collaboration with industry and the research sector.

The bid was guided by a steering committee comprised of industry and research experts including QUT's Executive Dean of Science and Engineering Professor Gordon Wyeth and robotics and autonomous systems professor Tristan Perez, from the Intellisensing enabling research platform within QUT's Institute for Future Environments.

QUT researchers are currently working to establish DCRC projects with industry partners including Boeing, Saab, EPE and AOS in the following key capability areas:

- certification of autonomy
- human-machine integration and trust
- robot perception and understanding
- resilient and self-healing platforms for persistent autonomy.

*Top: QUT has an integral role in the new $50 million DCRC for Trusted Autonomous Systems.
Credit: Sonja de Sterke, QUT.*

YAWL SIMPLIFIES CRISIS MANAGEMENT FOR EUROPEAN DEFENCE AGENCY

© European Union

"YAWL was chosen because of its complete set of features and its ability to quickly create running workflow prototypes," he said.

After the initial prototype phase the new system, known as the J1 FAS, became fully operational and is used in EU headquarters and for larger military exercises.

YAWL chief architect Dr Michael Adams, from the QUT Information Systems School, said YAWL had been downloaded more than 250,000 times across 170 countries for business, teaching and research deployments.

"The main aim of the system's design was to make it as flexible and extensible as possible, so it can support a large variety of different applications and uses," Dr Adams said.

The success of YAWL has also secured a research collaboration with China's Sun Yat-sen University, where two grants have enabled ongoing research into providing workflow management support in the Cloud.

KEY CONTACTS

Professor Arthur ter Hofstede
a.terhofstede@qut.edu.au

Dr Michael Adams
mj.adams@qut.edu.au

© European Union

Top: The EDA developed J1 FAS using YAWL systems. It is used to manage military operations, such as the 'EUNAVFOR MED Operation Sophia' mission pictured above. Credit: European Union.

The European Defence Agency (EDA) has used a QUT-developed business process management (BPM) software system in its personnel management application supporting the European Union's Common Security Defence Policy Crisis Management Operations.

QUT Professor Arthur ter Hofstede and Adjunct Professor Wil van der Aalst developed YAWL as a graphical language with a formal foundation to interpret and run workflow patterns.

"Patterns represent typical issues that one may encounter when supporting a business process, for example related to the coordination of tasks, the involvement of data, and the assignment of resources," Professor ter Hofstede said.

"The explicit representation of task coordination and resource allocation makes it relatively easy to modify an automated business process, making a business potentially more responsive to change."

Professor Andreas Hense, from the Hochschule Bonn-Rhein-Sieg, Germany, headed the development of this YAWL application for the EDA, which wanted to provide an individualised software solution – rather than buying one off the shelf – to its 28 member states, without having to pay any licence fees.

"The management of personnel in headquarters of European military missions is a complex task that differs in many respects from the human resources management processes in ordinary enterprises," Professor Hense said.

© European Union

QUT PARTNERS WITH RHEINMETALL DEFENCE

KEY CONTACT

Professor Arun Sharma
officeofresearch@qut.edu.au

Rheinmetall Defence Australia and QUT are focusing on pioneering research into autonomous systems as part of a new research partnership.

The partnership is funded through an $80 million Technology and Product Development Fund which Rheinmetall is establishing as part of the Australian Industry Capability program for the Commonwealth of Australia LAND 400 Phase 2 program.

Managing Director of Rheinmetall Defence Australia Gary Stewart said the fund covered both fundamental research into future technologies and ongoing product development.

"The fund will invest in the development of a range of new technologies and products for the Australian and global markets, ensure the sustainability of the industry in Australia, while also generating advanced manufacturing jobs and enriching the Australian economy," Mr Stewart said.

QUT Deputy Vice-Chancellor (Research and Commercialisation) Professor Arun Sharma said Rheinmetall Group's global defence and civilian business provided immense opportunities for the application of technological innovation and offered new and challenging problem sets for further research.

"In addition to research, this important partnership provides potential for education programs for our students to gain experience in a real-world environment," he said.

Mr Stewart said the technology fund and partnerships would create a clear pathway for STEM graduates to enter an industry focused on military vehicles, turret systems and automotive technologies.

"It will also allow a clear commercialisation pathway for local companies to both the Rheinmetall Defence and Rheinmetall Automotive global supply chains."

HUMAN -COMPUTER INTERACTION

Improving engagement and decision making.

Top: Distinguished Professor Peter Corke (second from left) joining a World Science Festival 2017 panel discussing human co-existence with human-like robots. Image courtesy of Queensland Museum.

MINDMAX FOR MENTAL FITNESS

KEY CONTACT

Professor Daniel Johnson
dm.johnson@qut.edu.au

In partnership with the AFL Players' Association, QUT developed an innovative app to help maximise wellbeing and resilience using the same wellbeing training that AFL players use. The QUT Games Research and Interaction Design Lab helped develop the MindMax app and its video games.

Top: Director of QUT Games Research and Interaction Design Lab Professor Daniel Johnson with QUT Research Fellow Dr Kellie Vella (background).

QUT and the AFL Players' Association teamed up to develop an innovative app that helps maximise wellbeing and resilience.

Funded by The Movember Foundation, the MindMax app guides users through the same wellbeing training AFL players use.

MindMax spokesperson and clinical psychologist Dr Jo Mitchell said conversations were too often driven by alleviating mental illness, rather than building mental fitness.

Director of the QUT Games Research and Interaction Design Lab Professor Daniel Johnson said training comprised of bite-sized, app-friendly sessions with interactive activities and video games to encourage social sharing and community building.

"Part of the strategy is to engage with people in a space they already inhabit – people are passionate about both the AFL and video games," Professor Johnson said.

"We're drawing on those passions to build a wellbeing tool that helps build resilience and the mental fitness to handle challenges that may arise in life."

QUT researchers helped develop video games for the app while colleagues at the University of Sydney Brain and Mind Centre led a naturalistic assessment trial.

Initial analysis showed improvement in users' wellbeing and attitude toward help-seeking over time.

Interviews with users provided evidence of them applying the wellbeing lessons embedded in the app to their own experiences and using MindMax to springboard positive changes in their lives.

QUT Research Fellow Dr Kellie Vella said interviews made it clear users found the app activities helpful as a way to identify paths to improved wellbeing in many aspects of their lives.

The MindMax app was downloaded 7115 times between June 2017 and March 2018.

Elite AFL players, including Gold Coast Suns ruckman Tom Nicholls and midfielder Michael Barlow, were ambassadors for the app and provided feedback.

MACHINES MUST THINK LIKE HUMANS TO BUILD TRUST

KEY CONTACT

Professor Peter Bruza
p.bruza@qut.edu.au

Professor Peter Bruza from the QUT School of Information Systems is leading research to develop and test quantum theory-based models that better explain and predict human decision making.

If we are to ever fully trust autonomous systems, these systems need to understand how humans problem-solve in ways that sometimes defy machine logic.

Professor Peter Bruza is leading a two-year challenge to develop and test quantum theory-based models that better explain and predict human decisions.

Professor Bruza said humans and robots may one day need to make decisions collaboratively under extreme and uncertain conditions, such as on the battlefield or in the wake of a natural disaster.

"The plethora of sources that need to be processed in order to make a decision is known as 'information fusion'.

"As humans, we are often comfortable with a decision if we think all sources combined are collectively trustworthy.

"However, our decision making can defy the laws of probability used by machines to make decisions and, therefore, be considered irrational.

"According to probability standards, the order in which information is received doesn't matter. The decision is the same whether receiving information source A before B, or the other way around.

"Humans don't always think that way. The order in which we receive information, inferences and the context in which we make a decision can sway our thinking."

Professor Bruza said quantum cognition models provided a better account of human thinking than traditional probabilistic models.

"Quantum cognition explains context - the interference a first judgement can have on subsequent judgements," he said.

Professor Bruza and his team aim to identify quantum cognition models for autonomous systems using online platforms like the Amazon Mechanical Turk to survey thousands of people and study their decision-making rationale.

His *Contextual Models of Information Fusion* project received US$241,000 in funding from the Tokyo-based Asian Office of Aerospace Research and Development.

DATA-DRIVEN EVOLUTION

Environmental management.

USING DRONES TO FIND AND PROTECT KOALAS

KEY CONTACT

Dr Grant Hamilton
g.hamilton@qut.edu.au

Drones and high-resolution imagery can be used to enable rapid estimation of koala abundance.
Credit: Anthony Weate, QUT

QUT is deploying drones in a high-tech effort to find and protect koalas in South East Queensland.

The two-year project, led by Dr Grant Hamilton, uses drones and high-resolution imagery to enable rapid estimates of koala abundance.

"The primary emphasis of this project is on the ecology of koala conservation, and we are using drones and automated imaging technology as tools to assist," Dr Hamilton said.

"Through the use of drones we will be able to better locate our native fauna, and to get more accurate estimates of their abundance so that we can make effective conservation decisions."

Dr Hamilton said the project was a world first in developing of a robust methodology to use drones in estimating numbers, accounting for errors in detection.

The project combines data analytics and automated identification, and involves Dr Simon Denman from QUT's School of Electrical Engineering and Computer Science.
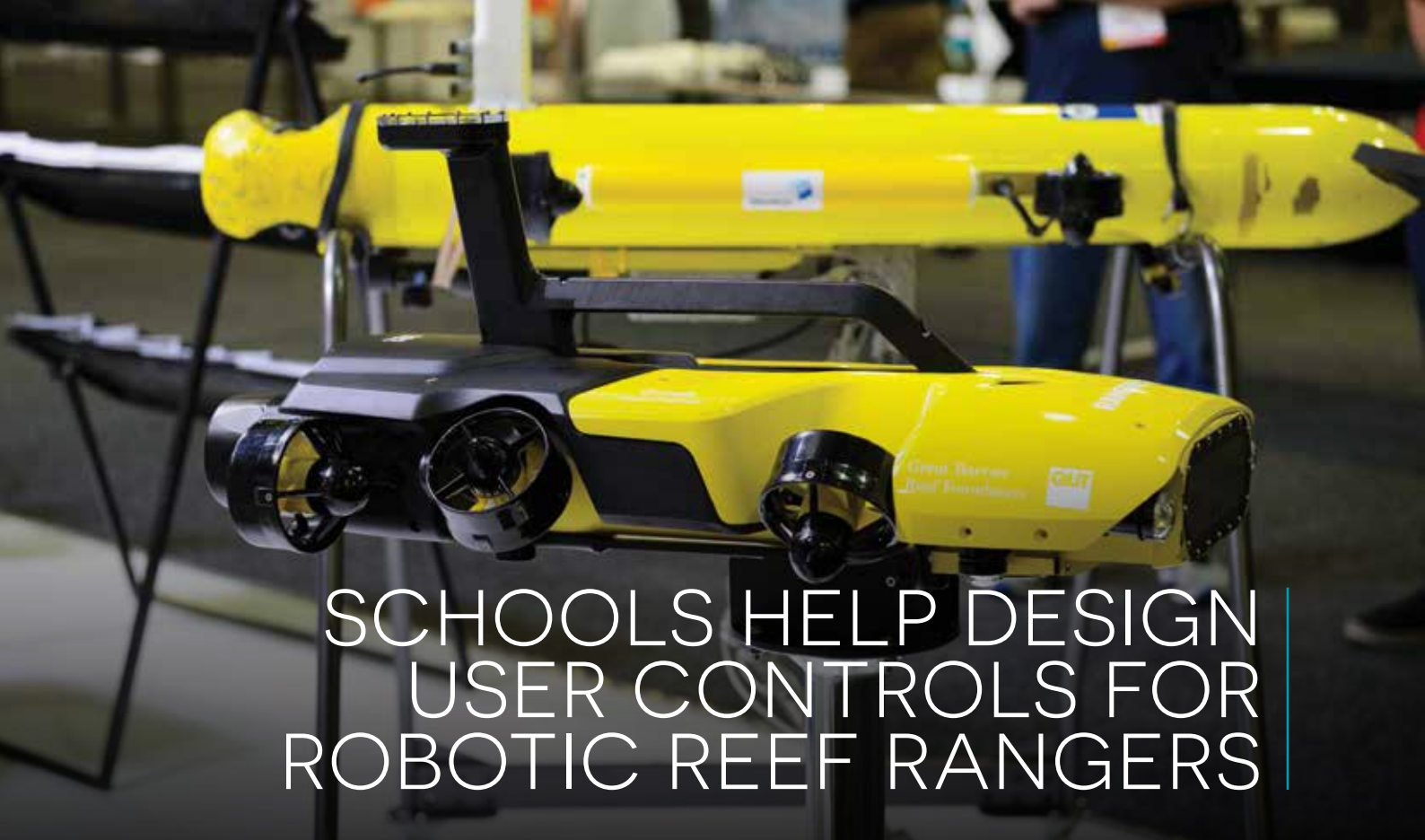
The Queensland Government provided funding as part of a strategy to protect and boost koala numbers in South East Queensland.

Results of this project could be deployed to protect other eco systems.

Research is led by Dr Grant Hamilton through the Quantitative Applied Spatial Ecology group. He is pictured with Dr Sandra Johnson. Credit: Anthony Weate, QUT.

SCHOOLS HELP DESIGN USER CONTROLS FOR ROBOTIC REEF RANGERS

KEY CONTACTS

Associate Professor Matt Dunbabin
m.dunbabin@qut.edu.au

Dr Feras Dayoub
feras.dayoub@qut.edu.au

More than 230 senior marine science students and teachers from 19 Queensland schools provided QUT researchers with insights to enhance the usability of state-of-the-art robots.

The researchers collected information about how non tech-savvy community members engaged with advanced robotic tools in order to better design and maximise take-up of these technologies.

Throughout 2016 and 2017 schools and community volunteers took part in wide-reaching surveys and controlled trials using remotely operated vehicles (ROV) to monitor the Great Barrier Reef.

Findings informed the user interface design for the QUT-developed RangerBot, a low-cost, user-friendly autonomous underwater vehicle developed with $750,000 in funding from the 2016 Google Impact Challenge Australia.

Associate Professor Matt Dunbabin, who co-created RangerBot and COTSbot, led the usability study.

"Through this study we've been able to assess the robot features, functionality and user interface we need to build to encourage and excite citizen scientists, schools and teachers to use the technology to save the reef," Professor Dunbabin said.

"Almost every participating school expressed a desire to expand their teaching and student learning through the integration of robotic technology into their marine science course.

"We want to maximise the use of technology in environmental monitoring programs around the world, so this was an encouraging indication of what we hoped to achieve on a larger scale through citizen science."

Top: QUT-developed AUV, RangerBot (front) and COTSbot (back).
Credit: Ben O'Sullivan.

Some 200 students, 30 teachers and four members of the Association of Marine Park Tourism Operators took part in the usability study.

The research was supported by QUT, Dalio Foundation, Lord Mayor's Charitable Foundation and the Eldon and Anne Foote Advised Trust.

RangerBot trials began in late 2017 and continued through 2018.

The research team is now assessing possible commercial applications and technology evaluation by tourism, fisheries, marine parks and other interested stakeholders.

QUT-developed, RangerBot and COTSbot. Credit Ben O'Sullivan.

1 diver can cover **1km** in a 3-hour work day — 1 km

1 RangerBot could cover up to **28km** in an 8-hour work day — 28 km

6 Human divers could only cover half the length of the reef in a year — 1/2

6 RangerBots could cover the length of the reef up to 14 times in a year — 14

6 divers would cost $1.44M to operate for the year

6 RangerBots would cost $720,000 to operate for the year

Divers typically doing a single task

RangerBots gathering multiple ocean measurements (temperature, acidity, visual mapping)

Divers operate during daylight hours only

RangerBots could operate day and night

$60 MILLION REEF RESTORATION INITIATIVE

SAVING SEAGRASS FROM DREDGING

KEY CONTACT

Dr Mark Gibbs
mark.gibbs@qut.edu.au

QUT is helping protect and restore the reef. Credit: Great Barrier Reef Foundation.

Below: Associate Professor Matt Dunbabin views the COTSBot monitoring coral reef on The Cube at QUT, Gardens Point campus.

QUT joined a consortium tasked with designing and scoping a major new restoration plan for Australia's iconic Great Barrier Reef.

In January 2018, the Australian Government announced a $60 million investment over 18 months in Great Barrier Reef protection and restoration programs.

This investment included $6 million to a consortium comprising the Australian Institute of Marine Science (AIMS), CSIRO, QUT, James Cook University, The University of Queensland and the Great Barrier Reef Foundation to scope and design a major new Reef Restoration and Adaptation Program.

QUT is contributing engineering, robotics, social impact assessment and modelling capabilities to help develop the knowledge and technology required to restore coral reefs at scale.

The program is built on an existing partnership between QUT and AIMS that led to the Monitoring Through Many Eyes (now called Virtual Reef Diver) citizen science program to document, analyse and predict reef health.

QUT and AIMS are also collaborating on submersible robots for reef monitoring and management.

QUT became a world leader in autonomous underwater vehicles (AUVs), after Associate Professor Matt Dunbabin and Dr Feras Dayoub developed the COTSbot robot to autonomously detect and control the devastating crown-of-thorns starfish (COTS).

They have since developed 'RangerBot', a smaller, more nimble and lower-cost version of COTSbot designed to provide communities with versatile, vision-enabled AUVs for monitoring and managing a range of marine issues.

KEY CONTACTS

Dr Paul Wu
p.wu@qut.edu.au

Statistician Paul Wu led research to develop a model that helps minimise the impact of marine dredging on seagrass.

It is estimated one hectare of seagrass can absorb 35 times as much carbon dioxide as a hectare of Amazon rainforest, as well as produce 100 thousand litres of oxygen per day.

Selecting the time to dredge is key to helping preserve one of the world's most productive and important ecosystems, seagrass meadows.

Dredging can significantly reduce the amount of light reaching the seagrass, which typically grows along shallow, gently sloping, protected coastlines and depends on light for photosynthesis.

A team of researchers studied 28 seagrass meadows around the world to provide answers on when and how much to dredge via an 'ecological window', using statistical modelling.

Lead researcher Dr Paul Wu, from QUT's School of Mathematical Sciences, developed a way of predicting the ideal time to dredge in order to give seagrass the best and quickest chance of recovery.

"Our model can provide up to fourfold reduction in recovery time and up to 35 per cent reduction in local extinction risk for seagrass species," Dr Wu said.

Dr Wu said the advanced statistical model also accounted for resilience, some areas of seagrass being stronger and healthier and capable of handling more stress.

"The model allows dredging and coastal development to move forward, but helps mitigate the environmental impacts on seagrass and the many ecosystems that depend on it," Dr Wu said.

Dr Wu said his Bayesian network model combined data with expert knowledge.

"The processes are too complex and there is too much variability in nature. We bolster the data we have with expert knowledge from seagrass scientists who dive on the seagrass beds, studying them and taking samples with decades of valuable experience."

Those experts come from the School of Sciences and Centre for Marine Ecosystems Research at Edith Cowan University, the Western Australian Marine Science Institution in Perth, the UWA Oceans Institute and School of Biological Sciences at the University of Western Australia, and the Centre for Tropical Water & Aquatic Ecosystem Research at James Cook University.

"What makes the model even more important is that it isn't limited to just seagrass. It could be used to model other natural ecosystems under stress, like mangroves and coral reefs," Dr Wu said.

Seagrasses provide shelter and food to an incredibly diverse community of life, from the tiniest of marine creatures to fish, turtles, dugongs, other marine mammals and birds.

QUEENSLAND'S OWN RAPID RESPONSE TOOL FOR MONITORING CORAL BLEACHING

KEY CONTACT

Associate Professor Felipe Gonzalez
felipe.gonzalez@qut.edu.au

Queensland researchers are developing a new tool to ramp up rapid response efforts to coral bleaching on the Great Barrier Reef.

QUT's remote sensing and unmanned aerial systems (UAS) experts are partnering with the Australian Institute for Marine Science (AIMS) to test whether small drones, machine learning and specialised hyperspectral cameras can monitor the Great Barrier Reef more quickly, efficiently and in more detail than manned aircraft and satellite surveys.

QUT's project leader Associate Professor Felipe Gonzalez said the team surveyed three reefs in the Great Barrier Reef Marine Park from 60 metres in the air while AIMS divers recorded precise levels of coral bleaching from under the water.

"By taking readings from the air and verifying them against the AIMS data from below the surface, we are teaching the system how to see and classify bleaching levels," said Professor Gonzalez an aeronautical engineer from QUT's Institute for Future Environments and Australian Centre for Robotic Vision.

> We see small drones with hyperspectral cameras acting as a rapid response tool for threatened reefs during and after coral bleaching events.

"Flying 60 metres above the water gives us a spatial resolution of 9.2 centimetres per pixel, which we've found to be more than enough detail to detect and monitor individual corals and their level of bleaching.

Roughly the size of Japan, the Great Barrier Reef is home to around 3000 reefs stretching 2300 kilometres, making it slow and costly to survey using traditional methods.

Miniaturised hyperspectral cameras and data analysis systems

Key to the new aerial system is miniaturised hyperspectral cameras, which until recently were so large and expensive only satellites and manned aircraft could carry them.

Professor Gonzalez said the hyperspectral camera, captures 270 bands in the visible and near-infrared portions of the spectrum, providing far more detail than the human eye can see and at an ultra-high resolution.

"You can't just watch hyperspectral footage in the same way we can watch a video from a standard camera – we must process all the data to extract meaning from it," Professor Gonzalez said.

"We're building an artificial intelligence system that processes the data by identifying and categorising the different 'hyperspectral fingerprints' for objects within the footage.

"An individual coral colony will give off different hyperspectral signatures as its bleaching level changes, so we can potentially track those changes in individual corals over time.

> A more cost-efficient and reliable detection system.

Managing pests and diseases in Australian vineyards

Professor Gonzalez also proved the high-tech drones successful in detecting the aphid-like insect grape phylloxera *(Daktulospaira vitifoliae)* in a research trial by QUT in partnership with Agriculture Victoria and the Plant Biosecurity Cooperative Research Centre.

Each vine gives off unique hyperspectral signatures, which change with the level of infestation.

Until now, ground surveys and ground traps have been used to determine the presence and level of any infestation. However, while these are accurate, they are expensive and time consuming.

There are more than 135,000 hectares of vineyards in Australia, with the industry contributing an estimated $40 billion to the nation's economy each year. Only select areas are affected by grape phylloxera.

In addition to developing a methodology to improve plant pest surveillance using UAS-based hyperspectral and spatial data, the research team created artificial intelligence algorithms to classify hyperspectral signatures in a unique database.

The same algorithm could also be used for other pests including botrytis, downy mildew, light brown apple moth, mealybugs, nematodes and powdery mildew.

Stopping weed invasions

QUT successfully used the drone system to automatically detect and map an aggressive weed in an effort to stop it spreading through Queensland's coastal dunes.

In collaboration with the Department of Agriculture and Fisheries and Aspect UAV Imaging, Professor Gonzales and his team focused on the invasive bitou bush – an introduced species that is growing out of control in New South Wales.

Bitou bush *(Chrysanthemoides monilifera)* is a Weed of National Significance. Most of Queensland's 6100 kilometre coastline is currently free of bitou bush. However, control of the weed is vital to protect the state's unique coastal flora.

"The automated analysis of the images gives a faster and more reliable method of detection as well as tangible and immediate benefits including, in this case, a precise and exact report of the weed via a GPS database, full coverage of the studied area in challenging terrain, and reduced times while gathering reports of the weed's distribution," Professor Gonzalez said.

SCIENTISTS AND FARMERS WORK TOGETHER TO WIPE OUT AFRICAN LOVEGRASS

KEY CONTACT

Associate Professor Jennifer Firn
jennifer.firn@qut.edu.au

African lovegrass.

Above: Associate Professor Jennifer Firn, Professor in Ecology, Ecological Applications, Plant Biology.

A partnership between QUT, the New South Wales (NSW) Government and farmers could lead to the eventual eradication of the highly invasive African lovegrass, which is threatening pastures and native grasslands Australia-wide.

Lead researcher Associate Professor Jennifer Firn previously tested control methods for the grass in southern Queensland and said local knowledge was key to a successful management approach.

"Landholders are in a unique position to witness species turnover in grasslands as well as learn from their own successes and failures in trying to manage invasive grasses," Professor Firn said.

Australian landholders considered African lovegrass a pest species because it was not selectively grazed by livestock and tended to dominate native pastures, reducing biodiversity and essential ecosystem functions.

QUT researchers worked with 15 landholders in the Bega region of NSW to examine the changing ecological characteristics of grassy woodlands and impact following the arrival of the exotic African lovegrass.

They then tested seven landholder-generated hypotheses at 57 sites on the landholders' properties, which validated many of their management perceptions.

Professor Firn said African lovegrass seeds can germinate even up to 17 years of age and are dispersed by grazing animals, slashing, vehicles, water, fodder and wind.

"One theory we tested was whether mechanically slashing African lovegrass and then putting a large number of cattle into the paddock was effective as some farmers think.

"We found the opposite was true and it only made the lovegrass more abundant. It was also an expensive exercise for farmers," Professor Firn said.

"Conversely, we discovered that an alternative control technique, 'roller-wiping' or spot spraying with herbicide, was effective even with heavy infestations, and cost efficient despite its poor reputation.

Professor Firn said local knowledge coupled with scientific methods could act in tandem as a smart approach for understanding and managing African lovegrass, as well as other invasive plants and animals.

The research project team included Associate Professor Jennifer Firn from the QUT School of Earth, Environmental and Biological Sciences, Emma Ladouceur from the University of Pavia, Italy, and Dr Josh Dorrough from the NSW Office of Environment and Heritage.

NEWLY DISCOVERED MARSUPIALS LISTED AS ENDANGERED

KEY CONTACTS

Dr Andrew Baker
am.baker@qut.edu.au

Dr Andrew Baker holding an antechinus. Credit: QUT Media

Top: Black-tailed dusky antechinus. Credit: Gary Cranitch, Qld Museum

The Australian Government has officially listed the black-tailed dusky antechinus and silver-headed antechinus as endangered following their discovery by QUT mammologist Dr Andrew Baker.

Dr Baker said he hoped the endangered listing provided greater protection for the two species, which he first discovered with his team in 2013, within South East Queensland.

"Australia has the worst mammal extinction rate anywhere on earth.

"We must take action, so I am pleased the Australian Government has approved this listing and enshrined the protection of the antechinus, and a range of other species, in federal legislation.

"We can now turn the country's attention to the important job of saving these threatened species.

"If we take immediate action, hopefully in time we will see the antechinus removed from the endangered list," he said.

In addition to the challenges posed by climate change, habitat loss and feral animals, the antechinus are also at risk from themselves.

Each year when the species mate, the males fight ferociously for sex – and then drop dead.

"These small marsupials have certainly courted a lot of attention for their mating habits.

"They are quite unique from that perspective, and we have been very fortunate to be able to capture some incredible vision of them in the wild," Dr Baker said.

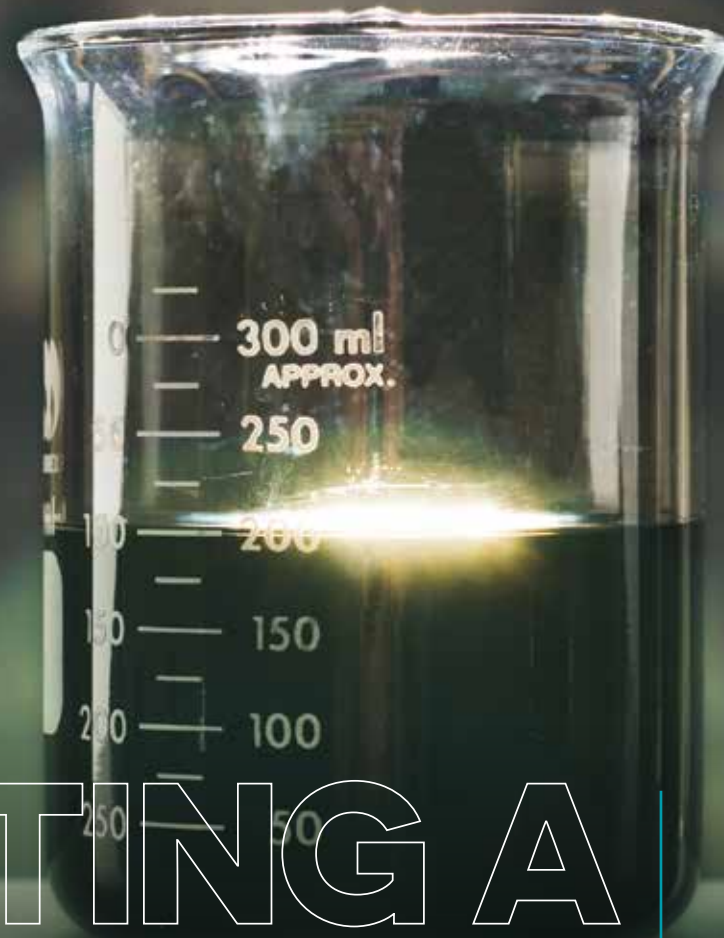There are 15 separate species of antechinus in Australia.

Antechinus are one of the world's 'vanishing species' that feature in a new book by Dr Baker and the University of Sydney's Professor Chris Dickman, called the *Secret Lives of Carnivorous Marsupials*.

CREATING A GREENER FUTURE

Building our bioeconomy.

Increased use of 10 per cent ethanol-blended petrol (E10) in Australia could create more than 8600 direct and indirect jobs, attract $1.56 billion in investment and generate more than $1.1 billion in additional revenue each year in regional areas, according to an industry report.

The *Biofuels to bioproducts: a growth industry for Australia* report released in March 2018 outlined the status of biofuels and bioproducts sectors in Australia and overseas.

It identified opportunities for Australia to build more profitable and sustainable agricultural industries that produced biofuels and bioproducts such as chemicals, plastics, enzymes and surfactants from crop residues, wastes and energy crops.

Lead author Professor Ian O'Hara, principal research scientist from the QUT Centre for Tropical Crops and Biocommodities, said the first step to creating a successful Australian bioeconomy was to grow our bioethanol and other biofuels industries.

"It is clear that biofuels industries can grow economies, particularly in regional and rural areas where there is an abundance of agriculture residue that can be transformed into high-value bioproducts," Professor O'Hara said.

"Bioethanol, which is the cleanest alternative for increasing the octane content of petrol and improving fuel and vehicle performance, is one example.

"In Australia, E10 ethanol-blended petrol accounted for only 1.1 per cent of the total sales of petrol in 2015-16.

"Increasing domestic production of bioethanol and the sales of ethanol-blended petrol to 10 per cent of total petrol consumption would have significant benefits in job creation, increased investment, and additional regional income."

The report identified other benefits to Australia of growing its biofuels and bioproducts industries:

- Potential revenue to farmers from biomass-based industries rising from less than $7.8 billion per year to more than $11.4 billion by 2050.
- Carbon dioxide emissions reduction of 8.9 million tonnes annually by increasing biofuels use up to 10 per cent in both petrol and diesel across Australia.
- Better fuel security, and fuel imports reduced by 18 per cent annually, through implementation of a national mandate or target for 10 per cent ethanol blending in petrol.
- Balance of trade improved by about $1 billion annually by substituting 10 per cent of petrol imports with ethanol produced domestically.

Endorsed by Bioenergy Australia, the report outlined a five-point plan to grow Australia's biofuels and bioproducts industry:

1. Develop a national biofuels, bio-based and bioeconomy strategy.
2. Implement a national biofuels mandate supporting the introduction of higher quality fuels.
3. Provide support mechanisms, education, incentives and infrastructure.
4. Establish policy frameworks for advanced/drop-in biofuels, biochemicals and bio-based products.
5. Support commercial developments through industry and research collaboration.

QUT Adjunct Professor Karen Robins, and Bas Melssen from Novozymes Asia Pacific co-authored the report.

Professor O'Hara is Queensland's inaugural Biofutures Industry Envoy.

www.manildra.com.au/ebooks/biofuels

KEY CONTACT

Professor Ian O'Hara
i.ohara@qut.edu.au

BIOPRODUCTS A POTENTIAL GAME CHANGER FOR FARMERS

A $14 million national research project aims to produce high-value bioproducts out of waste from the beef, dairy and pork industries.

Lead researcher Professor Ian O'Hara said the project aimed to develop profitable processes for turning livestock industry wastes into bioenergy and valuable bioproducts.

"We'll be investigating how beef, dairy and pork wastes, which could include processing wastes and manure, can make products such as animal feeds, fertilisers, fuels, chemicals, and plastics for specialty applications.

"The technologies being developed will result in increased revenue and reduced costs for producers, leading to increased profitability and sustainability."

The project will be managed by Meat & Livestock Australia through $6 million in funding from the Australian Department of Agriculture and Water Resources as part of its Rural R&D for Profit program.

A further $8 million in cash and in-kind commitments came from 18 project partners including meat processors, utility companies and technology developers.

Other research partners included The University of Queensland, University of Southern Queensland and Murdoch University.

KEY CONTACT

Professor Ian O'Hara
i.ohara@qut.edu.au

HELPING U.S. TECH FUEL BAGASSE RESEARCH

QUT is testing a novel technology developed by Mercurius Biorefining to convert biomass into jet and diesel fuels.

Mecruius Biorefining developed Renewable Acid-hydrolysis Condensation Hydrotreating (REACH) technology, which has three main processing steps and is similar to techniques already in use in the petroleum, pulp and paper industries.

QUT will demonstrate the first two steps and, from these, produce pre cursor fuel products (bio-crude) for subsequent conversion to jet and diesel fuels and testing by other project partners.

The project aims to optimise the processes of patented REACH technology for efficiency and cost-effectiveness and help determine achievable yields and quality of fuel converted from sugarcane bagasse and other biomass.

Mercurius Biorefining founder and CEO Karl Seck met with QUT researchers and discussed plans to establish pilot plants for its technology in regional Queensland.

The project is funded by the Queensland Department of State Development, Manufacturing, Infrastructure and Planning.

KEY CONTACT

Dr Darryn Rackemann
d.rackemann@qut.edu.au

Top (left to right): Dr Dylan Cronin; Dr Darryn Rackemann and Dr Joshua Howard with Mr Karl Seck, CEO of Mercurius Biorefining.

A POWERFUL NEW USE FOR OLD TYRES

KEY CONTACT

Professor Richard Brown
richard.brown@qut.edu.au

Top (left to right): Farhad Hossain, Professor Richard Brown and GDT's Trevor Bayley in QUT's Biofuel Engine Research Facility with a truck tyre that would yield 460 litres of reclaimed oil.

Old tyres can be completely recycled into lower-emission diesel engine oil instead of being dumped in dangerous, highly flammable stockpiles.

QUT mechanical engineers tested oil extracted from old tyres in a process developed by Australian company Green Distillation Technologies (GDT).

When blended with diesel the oil produced a fuel with lower emissions and no loss of engine performance.

Positive performance in lab tests

Professor Richard Brown, director of QUT's Biofuel Engine Research Facility, and PhD student Farhad Hossain tested oil emissions and output in the QUT Biofuel Engine Research Facility, the most sophisticated fuel-testing facility in the Southern Hemisphere.

"We found a 30 per cent reduction in nitrogen oxide which contributes to photochemical smog, and lower particle mass which means fewer problems for emission treatment systems," Farhad Hossain said.

The QUT research team also included process engineer Dr Tom Rainey and air-quality expert Professor Zoran Ristovski.

No loss of performance on the road

On-road testing of a vehicle using the fuel found no loss of performance and emissions were similar to that of diesel-only fuel.

Professor Brown and Dr Tim Bodisco from Deakin University tested the 10 per cent tyre oil/diesel mix in a 2.5 litre engine 2017 Hyundai iLoad van which has an engine similar to SUVs and 4WDs and is a vehicle favoured by couriers.

They compared its performance and emissions with those from the same van driven under the same conditions with diesel-only fuel.

"The on-road tests showed the fuel mix was compatible with a popular engine type and produced no adverse effects in power and performance," Professor Brown said.

Dr Bodisco said the fluctuations in nitrogen oxide emissions depended on traffic and environmental conditions.

"We need to gain an understanding of the causes to help vehicle manufacturers and regulators to better manage vehicle emissions," he said.

GDT Chief Operating Officer Trevor Bayley said tests showed recycled tyre oil could be used with diesel in a vehicle without further refining.

"The oil that comes from our process is a crude oil and the on-road tests show that it can be used in this way," he said.

Recycled tyre oil as a diesel additive could provide a solution to the global stockpiling of 1.5 billion tonnes of used tyres each year, including the 55 million tyres discarded by Australians annually.

A recycled 10kg car tyre yields 4 litres of oil, 1.5kg of steel and 4kg of carbon. A 70kg truck tyre provides 28 litres of oil, 11kg of steel and 28kg of carbon.

Below: Professor Richard Brown from QUT and Dr Timothy Bodisco from Deakin University check tyre-oil diesel fuel emissions data collected from the November Hyundai iLoad test drive.
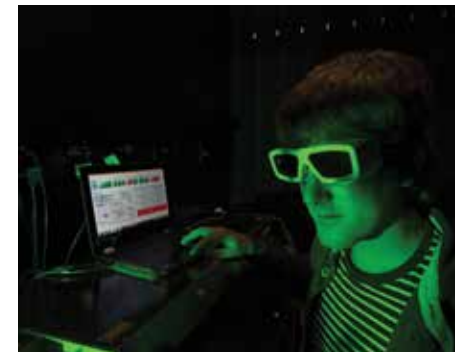
NEW MATERIALS

Processes driving innovation.

LIGHT SWITCHING CHEMICAL REACTIONS TO REVOLUTIONISE MANUFACTURING

KEY CONTACT

Professor Christopher Barner-Kowollik
christopher.barnerkowollik@qut.edu.au

QUT Professor Christopher Barner-Kowollik (top right) co-supervised the collaborative international research project. Lead author of the paper Hannes Houck (top left and below) is conducting PhD studies across the three partner institutions. Credit: QUT.

A new chemical light-switching process could make manufacturing integrated circuits and chips for everyday electronic devices simpler, safer and cheaper.

Researchers from QUT, Karlsruhe Institute of Technology and Ghent University pioneered a system that modulates visible, coloured light to change the reactions of a powerful chemical coupling agent.

Green laser light was used to control the reactivity of triazolinediones (TADs), coupling agents which swiftly create bonds with other chemicals, necessary to make materials.

Under green light the TADs stopped reacting; when the light was switched off, the TADs became highly reactive again.

The experiment showed two different products could be created from the same set-up, and repeated multiple times.

QUT's Professor Christopher Barner-Kowollik, who co-supervised the research, said the discovery opened up possibilities for future industry applications in chemical and advanced manufacturing, including computer chip fabrication.

"At the moment ultraviolet light, which has shorter wavelengths than light in the visible spectrum, is used in industry to drive chemical processes," said Professor Barner-Kowollik, an Australian Laureate Fellow.

"Industrial processes making use of less harmful visible light are scarce – a sharp contrast to what occurs in nature.

"For plants, visible light plays a critical role in chemical processes. Trees harvest light during the day and use this as an energy source to grow, releasing oxygen in the process. At night, however, when light is no longer available, the chemical process is altered and plants release carbon dioxide.

"We've been inspired by such natural processes and designed a completely light-switchable chemical reaction system for the first time."

Researchers said their system may be applied to create light-sensitive materials for 3D laser lithography, allowing printing of very small structures that could be used in things such as computer chip fabrication.

3D laser lithography is a type of 3D printing with direct laser light, used for creating very precise structures in the micro range, such as scaffolds for cells.
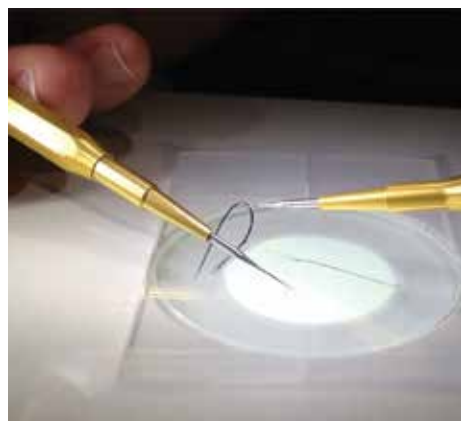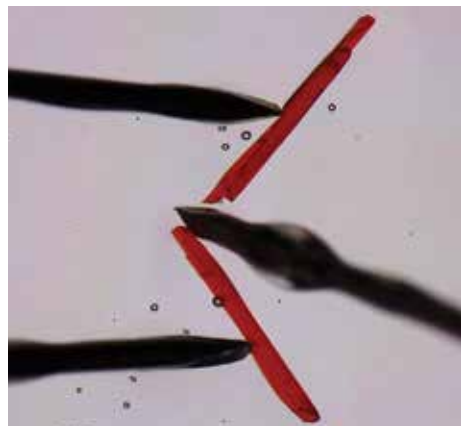
Professor Barner-Kowollik and his team at QUT are exploring 3D laser lithography applications with leading physicist Professor Martin Wegener from Karlsruhe Institute of Technology.

BENDABLE CRYSTALS TIE CURRENT THINKING IN KNOTS

KEY CONTACT

Associate Professor John McMurtrie
j.mcmurtrie@qut.edu.au

A single crystal of copper (II) acetylacetonate tied in a knot. Copyright QUT.

For the first time, researchers determined and measured the structural mechanism behind the elasticity of a crystal down to the atomic level, an achievement that has wide-ranging industrial and technological implications.

The research was led by Australian Research Council (ARC) Future Fellows Associate Professor Jack Clegg, from the UQ School of Chemistry and Molecular Biosciences, and Associate Professor John McMurtrie from the QUT Science and Engineering Faculty.

The researchers grew bendable crystals about the width of a fishing line and up to five centimetres long from a common metal compound – copper (II) acetylacetonate.

When the crystals were bent, researchers mapped changes in the atomic scale structure using X-ray measurements performed at the Australian Synchrotron.

Crystals from six other structurally-related compounds, some of which contained copper and other metals, were also tested and found to be flexible.

Associate Professor Clegg said the experiments showed the crystals could be repeatedly bent and returned quickly to their original shape with no signs of breaking or cracking when the force bending them was removed.

"Under strain the molecules in the crystal reversibly rotate and reorganise to allow the compression and expansion required for elasticity and still maintain the integrity of the crystal structure," he said.

"Flexible crystals like these could lead to new hybrid materials for numerous applications, from components of planes and spacecraft to parts of motion or pressure sensors and electronic devices."

Associate Professor McMurtrie said the method developed to measure the changes during bending could also be used to explore flexibility in other crystals.

"Bending the crystal changes its optical and magnetic properties, and our next step is to explore these optical and magnetic responses to identify applications in new technologies."

The research was funded by an ARC Discovery Grant and supported by the Australian Synchrotron.

OUR GREATEST ASSETS

Our people.

Fellow of the Australian Academy of Science, Distinguished Professor Kerrie Mengersen. Credit: Vanessa Hunter

QUT mathematical and statistical scientist Distinguished Professor Kerrie Mengersen was named a Fellow of the Australian Academy of Science, joining the ranks of the nation's most distinguished scientists.

Professor Mengersen focuses on using and developing new statistical and computational methods to help solve complex problems in diverse fields including the environment, genetics, health and medicine, and industry.

Her methodology has been used in pioneering projects to map where people with cancer live, firstly in regional Queensland and now across Australia, allowing health agencies, policy makers and the community the opportunity to understand cancer locations and where resourcing is needed.

She has also worked on projects to protect critically endangered cheetahs in southern Africa and orang-utans in Indonesia, to identify a jaguar corridor to the Peruvian jungle so the animals can roam safely, and to monitor the health of the Great Barrier Reef by tapping into local knowledge and building statistical and virtual reality models to guide conservation efforts.

"One of the things I love about my work is showing how mathematics and statistics underpin every area of our lives," she said.

"Data literacy is such an important skill for everyone. Statistics allows us to know what the data is really telling us and how we can use data to make better decisions."

In 2015 Professor Mengersen was awarded an Australian Research Council (ARC) Australian Laureate Fellowship and she is a Deputy Director and Chief Investigator of the ARC Centre of Excellence for Mathematical and Statistical Frontiers, which has one of its largest nodes at QUT.

She is the first woman to receive the prestigious Pitman Medal from the Statistical Society of Australia, which recognises outstanding achievement in the statistics discipline.

Professor Mengersen is among 21 scientists, and one of two from Queensland, to be elected this year to the Australian Academy of Science.

The appointment acknowledges Professor Mengersen's internationally recognised and significant contributions in the field of Bayesian statistics theory, methodology and computation, and its application to substantive problems.

Spine research, intervention and drug treatments.

Professor Peter Pivonka

Chair of Biomedical Engineering and Spinal Disorders and Director of the Spine Research Group

Professor Peter Pivonka joined QUT as our Director of Spine Research Group.

He also works on projects such as intervention of osteoporosis with exercise and drug treatments, and understanding bone adaptation to mechanical loading using animal and computational models.

Professor Pivonka is a musculoskeletal expert who established mechanobiology and bioengineering as priority areas, to promote novel interdisciplinary approaches to orthopaedic and bone-biology research.

He is nationally and internationally recognised for his work on mechanobiological regulation of bone tissue and multiscale modelling of materials.

Professor Pivonka's research interests are in mechanobiology, biomaterials, tissue engineering, musculoskeletal diseases and clinical interventions, estimation of material properties, multiscale modelling, systems biology, and high-resolution X-ray imaging.

CONTACT

peter.pivonka@qut.edu.au
staff.qut.edu.au/staff/Pivonka

Soft matter development focusing on light-driven photochemical transformations.

Professor Christopher Barner-Kowollik

Australian Laureate Fellow and Professor in Polymer Science

QUT Professor Christopher Barner-Kowollik heads the Soft Matter Materials Laboratory at QUT, and the Macromolecular Architectures research team at Karlsruhe Institute of Technology (KIT).

He is a world-leading soft matter nanotechnologist who focuses on real-world applications of light.

In 2017 he was awarded an Australian Laureate Fellowship and Australian Research Council (ARC) funding of more than $3 million to investigate how monochromatic light provided by lasers could be used to program and reprogram coatings and materials to make them adaptable and adjustable to their specific environment.

Professor Barner-Kowollik is based at QUT and has a fractional appointment with the KIT in Germany.

CONTACT

christopher.barnerkowollik@qut.edu.au
staff.qut.edu.au/staff/barnerko

New ultralight and super-strong structural composites and green-energy nanomaterials.

Professor Dmitri Golberg

Australian Laureate Fellow and Head of the Inorganic Nanomaterials Laboratory

Professor Dmitri Golberg joined QUT in March 2017 from his long-held position at Japan's National Institute for Materials Science to investigate new materials and their structural and green-energy applications using in situ transmission electron microscopy.

Professor Golberg is a world-recognised material scientist with expertise in nanotubes and metallic alloys. He instigated a new field of nanoscale study focusing on the physics, chemistry and functional properties of inorganic nanotubes filled, joined and/or coated with metals.

He has a strong background in the synthesis, structural analysis, and physical property measurement of diverse inorganic nanotubes, nanowires, graphene-like nanosheets, nanoribbons and nanobelts.

Professor Golberg pioneered studies on boron nitride nanotubes (nano-BN) and is a world-leading expert on the topic, having published more than 200 papers.

Much of his nanotechnology-related work focuses on the fabrication of prototype photodetectors, fuel and solar cells, Li- and Na-ion batteries, hydrogen accumulators, field and electron emitters, and structural nanocomposites made of various advanced nanomaterials synthesised in his laboratories.

CONTACT

dmitry.golberg@qut.edu.au
staff.qut.edu.au/staff/golberg

THE PICK OF AMAZON ROBOTICS CHALLENGE

KEY CONTACT

Dr Juxi Leitner
j.leitner@qut.edu.au

The 15-member team solved a key robotics problem for Amazon.

The QUT-headquartered Australian Centre for Robotic Vision grabbed the USD$80,000 first prize at the Amazon Robotics Challenge 2017 with a robot built by the team members.

The 15-member team solved a key robotics problem for Amazon – picking items and stowing them in boxes in an unstructured environment.

The challenge combined object recognition, pose recognition, grasp planning, compliant manipulation, motion planning, task planning, task execution, and error detection and recovery.

Robots were scored by how many items they successfully picked and stowed in a fixed amount of time.

Team ACRV leader Dr Juxi Leitner said the centre's secret was its innovative Cartesian manipulator, dubbed Cartman, that moved along three axes like a gantry crane, and incorporating a rotating gripper.

"With six degrees of articulation and both a claw and suction gripper, Cartman gives us more flexibility to complete the tasks than an off-the-shelf robot."

Sixteen international teams tested their hardware and software solutions in the 2017 challenge in Nagoya, Japan, which was designed to fill a gap in Amazon's automated warehousing processes.

While Amazon is able to quickly package and ship millions of items to customers from a network of fulfilment centres, commercial technologies that allow robots to pick items and stow them in boxes in an unstructured environment are yet to be developed.

Top: Distinguished Professor Peter Corke was named Australian University Teacher of the Year in the 2017 Australian Awards for University Teaching.

Left (top to bottom): Other Distinghished Professors from the Science and Engineering Faculty include James Dale AO, Dietmar W. Hutmacher, and Kerrie Mengersen.

Distinguished Professor Peter Corke became the nation's top university teacher in 2017 through the Australian Awards for University Teaching.

Australian University Teacher of the Year is the country's most prestigious higher education teaching award.

The award, part of the Australian Government's Australian Awards for University Teaching (AAUT), acknowledges an exceptional record of advancing student learning, educational leadership and scholarly contribution to teaching and learning.

Professor Corke's achievements included development of the innovative online educational resource Robot Academy, QUT's series of Massive Open Online Courses, in robotics and popular textbook *Robotics, Vision and Control*.

He is also director of the QUT-based Australian Centre for Robotic Vision.

Seventeen teaching excellence awards across eight categories were presented, celebrating university teachers for their outstanding skills and broad and deep contribution to enhancing the quality of higher education learning and teaching.

QUT Associate Professor Laura Gregory from the Faculty of Health also received a 2017 AAUT Award for Teaching Excellence.

Professor Corke, from QUT's Science and Engineering Faculty, was recognised in the category of Physical Sciences and Related Studies, while Associate Professor Gregory, was recognised in the Biological Sciences, Health and Related Studies category.

Since the AAUT's inception, QUT has received 113 awards across the Citations, Teaching Excellence and Program categories.

Distinguished contributions

In the same year, QUT awarded the title of Distinguished Professor to Peter Corke for his outstanding achievements in the field of robotics, which included an exceptional h-index of 60 and 20,000 citations.

This was the eighth QUT award of Distinguished Professor, following those given to Federation Fellow Professor John Hartley, Professor James Dale AO, Professor Stuart Cunningham AM, Professor Judith Clements AC, Professor Aileen Moreton-Robinson, Professor Kerrie Mengersen, and Professor Dietmar Hutmacher.

QUT ROBOT ACADEMY
MARKS ONLINE SUCCESS

The QUT Robot Academy celebrated its first birthday with its own impressive data set.

Since launching in 2017, more than 36,000 students from around the world have logged almost 300,000 lesson views across 13 different subject areas.

Distinguished Professor Peter Corke said robotics was an exciting field in which to work and it was wonderful to be able to share that knowledge.

"The QUT Robot Academy is an open, online, robotics education resource that provides more than 200 short lessons on specific robotics topics, including robot arms and computer vision, with courses at the equivalent of a second or third year university level."

Professor Corke said he was encouraged by the demographics of those accessing the online lessons.

"It's not surprising that most of our users are under 35, but what is interesting is that there is also a significant cohort in the 65-plus bracket.

"In addition to that, almost half of the overall number of users are female, which is much higher than an average university classroom," Professor Corke said.

www.robotacademy.net.au
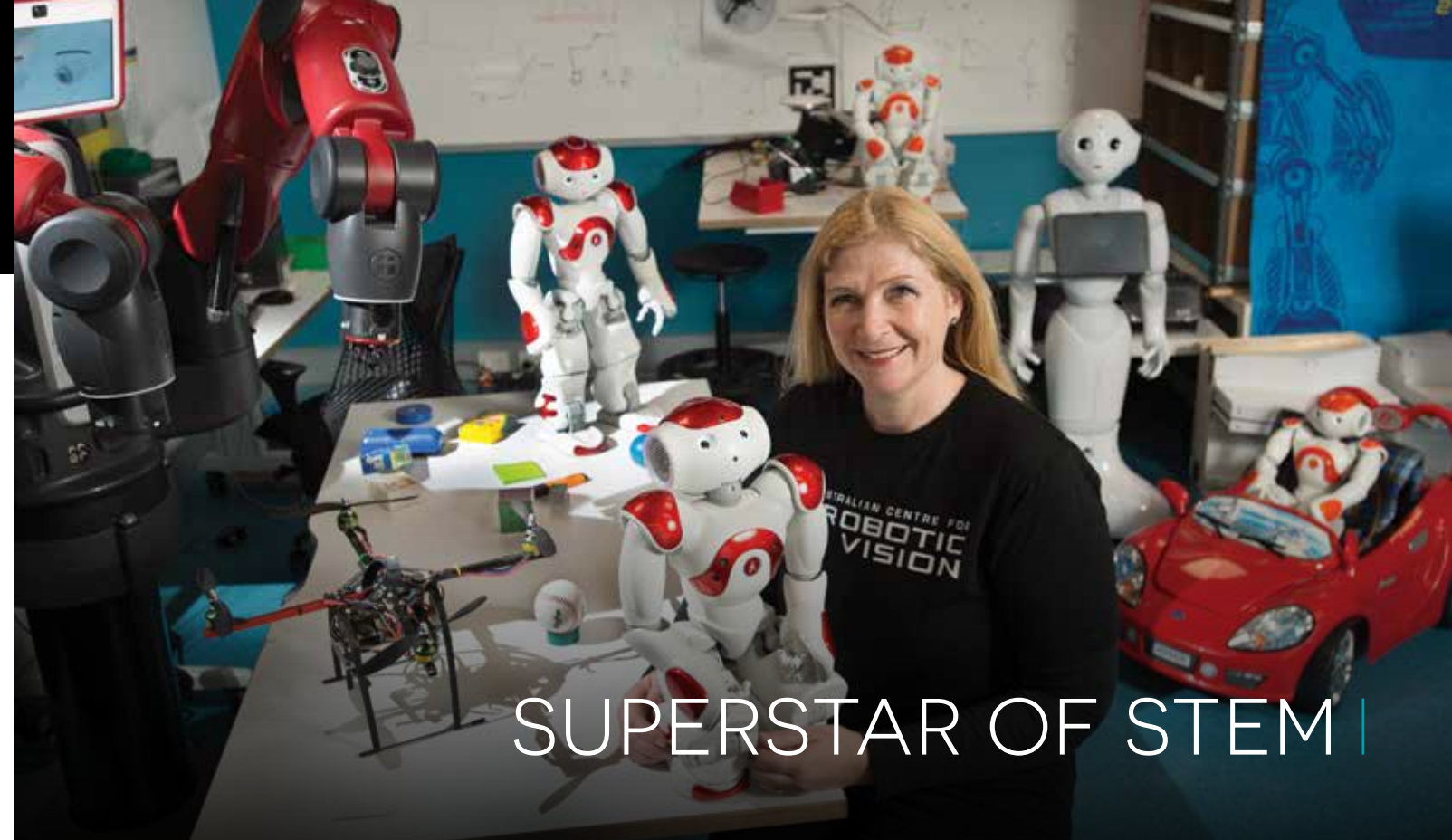
SUPERSTAR OF STEM

She already leads a national team of roboticists giving robots the gift of sight - now Dr Sue Keay is a mentor and role model for young women in science, technology, engineering and mathematics (STEM) across Australia.

The QUT-based Chief Operating Officer of the Australian Centre for Robotic Vision is one of only 30 women named Superstars of STEM by Science & Technology Australia (STA).

Dr Keay was selected from more than 300 applicants in the inaugural year of the program.

STA's program aims to support female leaders in communicating their science and inspiring others to consider careers in STEM.

"This program is vital to ensure that women participate and remain engaged in STEM," Dr Keay said.

"There are very few women in technology. There are even fewer in robotics and computer vision. Yet, the opportunities to change the world in these fields is incredible.

"I am highly motivated to raise the profile of technology, especially amongst women, to ensure that Australia is prepared for the significant changes that will soon engulf us.

"From robotic process automation to autonomous vehicles, things that were once in the realm of science fiction will soon become a reality."

Recently, Dr Keay developed a successful $1.5 million R&D project on humanoid robotics supported by the Queensland Government to explore the vision capabilities of Softbank's social robot, Pepper.

STA said the Superstars of STEM program also includes a mentoring component. Participants share their stories at local high schools to ensure they are connecting with young Australian women interested in STEM.

"We want Australian girls to realise that there are some amazing, capable and impressive women working as scientists and technologists too, and that they work in and out of the lab in places you might not expect," says Professor Emma Johnston, STA President-Elect.

The 30 women selected for the Superstars of STEM program received training and development to use social media, TV, radio and public speaking opportunities to talk about their science and to spread the word about the women in STEM.

Top: Dr Sue Keay, Chief Operating Officer of the QUT-based Australian Centre for Robotic Vision, was named a Superstar of STEM and is inspiring to others to STEM careers.

QUT FINALISTS IN YOUNG TALL POPPY SCIENCE AWARDS

Above (left to right):
Professor Jonathon Roberts (research supervisor) with Dr Anjali Jaiprakash, Queensland Science Minister Leeanne Enoch, Dr Indira Prasadam with her research supervisor, Professor Yin Xiao.

Top young QUT researchers were finalists in the Queensland Young Tall Poppy Science awards.

Dr Anjali Jaiprakash and Dr Indira Prasadam were honoured for excellence in their respective fields of medical robotics and bone and cartilage disorders.

Dr Jaiprakash is developing a vision-based robotic leg-manipulation system for knee arthroscopy and a retinal diagnostic system for the early detection of blindness.

Dr Prasadam's research focus is in osteoarthritis and developing treatments to ease knee pain, which affects one in four Australians.

The QUT researchers were among 12 finalists in the awards, which highlight intellectual and scientific excellence and encourage young Australians to pursue careers in science.

The annual Queensland Young Tall Poppy Science Awards was hosted by the Australian Institute of Policy and Science (AIPS) in partnership with the Office of the Queensland Chief Scientist.

HUMBOLDT AWARD AIDS BIOMEDICAL ENGINEERING RESEARCH

Distinguished Professor Dietmar W. Hutmacher received the prestigious Humboldt Research Award from The Alexander von Humboldt Foundation, Germany, for pioneering research in biomedical technology and medical physics.

The award included a €60,000 monetary prize that is helping Professor Hutmacher to strengthen his collaborations with the Max Planck Institute of Colloids and Interfaces, Germany.

Originally trained as an engineer, Professor Hutmacher is one of the few academics in the field of biomaterials/tissue engineering to have taken a research program from fundamental research through to clinical application using research in-vitro, in-vivo, preclinical models and clinical trials.

Humboldt Research Award

The Humboldt Research Award recognises a researcher's entire achievements to date. It is awarded to academics whose fundamental discoveries, new theories or insights have had a significant impact on their own discipline, and who are expected to continue producing cutting-edge achievements in the future.

Distinguished Professor Dietmar W. Hutmacher received the prestigious Humboldt Research Award from The Alexander von Humboldt Foundation.

GERMANY'S RICHEST RESEARCH PRIZE AWARDED TO A LEADING MIND IN COMPUTER SCIENCE

UNLOCKING THE WONDERS OF NATURE'S NANOSTRUCTURES

Hailed as one of the leading minds in computer science, The Alexander von Humboldt Foundation awarded QUT Adjunct Professor Wil van der Aalst one of its annual professorships.

The Alexander von Humboldt Professorship includes €5 million for research of Professor van der Aalst's choosing.

Professor van der Aalst has collaborated on business process management research with QUT School of Information Systems since 2003.
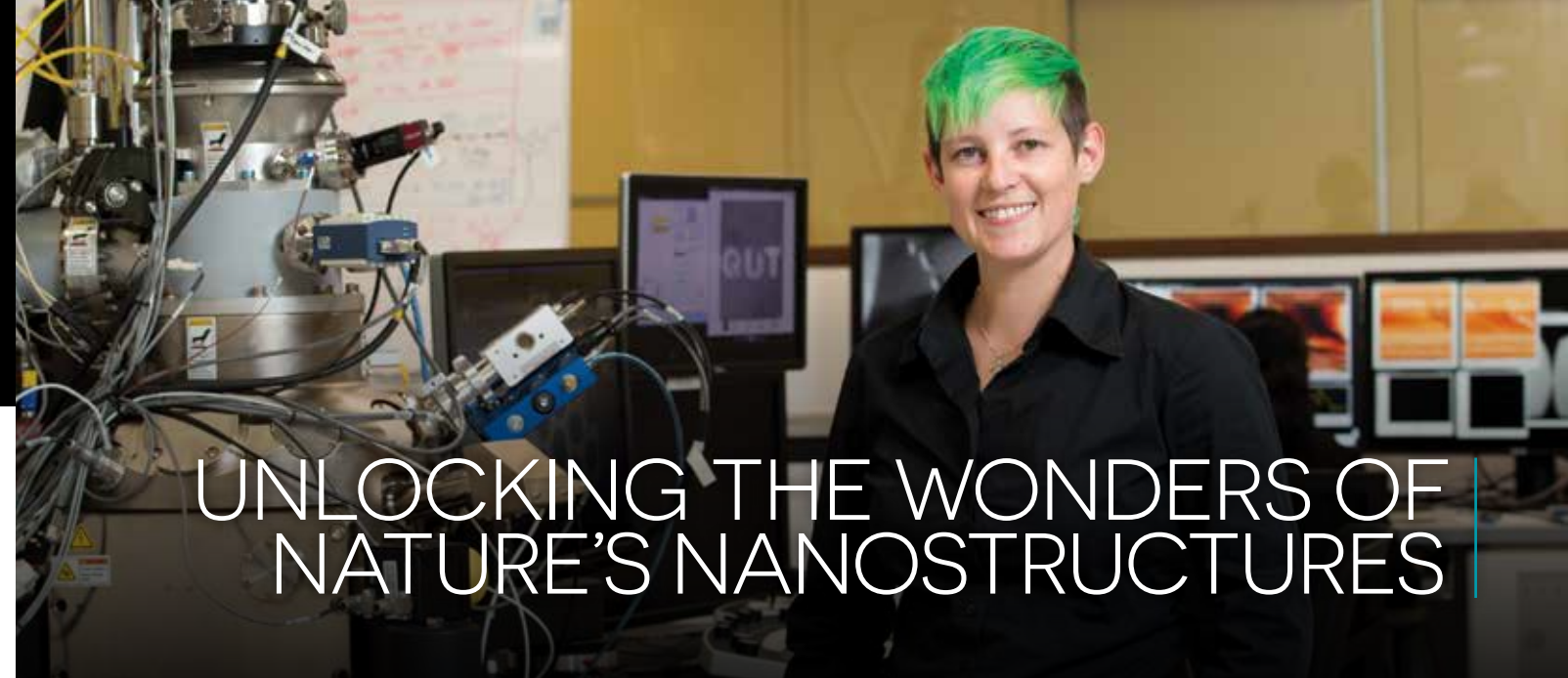
He is regarded as the founder of the field of process mining.

Although still a young field, process mining has led to a range of dedicated and specialised techniques, inspired by related fields such as data mining and machine learning.

The Alexander von Humboldt Foundation

Every year The Alexander von Humboldt Foundation enables more than 2000 researchers globally to spend time researching in Germany. The foundation maintains a network of more than 28,000 Humboldtians from all disciplines in more than 140 countries worldwide – including 55 Nobel Prize winners.
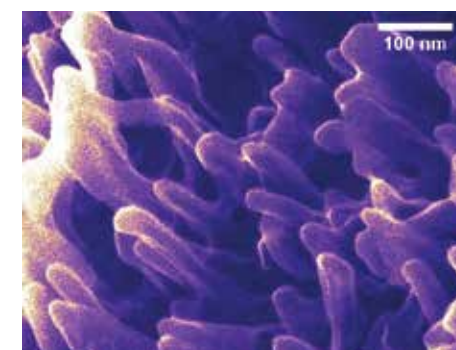
Credit: Bart van Overbeeke

KEY CONTACT

Dr Annalena Wolff
annalena.wolff@qut.edu.au

The 'fingers' on a dragonfly wing are so small that one million of them side-by-side would only be as long as a wasp.

Top: Dr Annalena Wolff can identify, manipulate and design materials at the atomic level with ion microscopes.

Dr Annalena Wolff, QUT's research infrastructure specialist in ion beam microscopy, won the 2017 Fresh Science Judge's Award (Southeast Queensland) national competition for her technique to measure biological material.

The award helps early-career researchers find and share their stories by providing media training and public speaking experiences.

Dr Wolff used her technique when working with primary chemistry researcher and PhD candidate (now graduated) Dr Chatarunga Bandara to discover how dragonfly wings trap and destroy bacteria.

In the past, ion and electron microscopes burnt biological material, but Dr Wolff developed new techniques to overcome this problem.

She used very powerful microscopes to see nature's smallest structures in three dimensions.

The researchers found dragonfly wings trap bacteria in the more than 10 billion very tiny 'fingers' (nanostructures) lining their surface.

"The 'fingers' on the wings are so small that even one million of them, put side by side, would be only just as large as a wasp. While trying to escape, the bacteria literally tear themselves apart," Dr Wolff said.

How would a microscope help build something?

Dr Wolff said microscopes used to image dragonfly wing nanostructures would also help researchers to design new bacteria-killing surgery tools and hospital equipment.

"We can use the same microscopes to rebuild the dragonfly wing 'fingers' using different materials or build robots so small that you could fit 64 billion of them in a single raindrop. You are only limited by your imagination."

The different ions, used in ion microscopes, can remove sample atoms with nanometre precision and carve any structure into different materials, from structures as small as a DNA strand to those as wide as a human hair.

Top: Some of QUT's 500 HEA Fellows.
Credit: QUT Media.

INTERNATIONALLY RECOGNISED TEACHING ACHIEVEMENT

QUT reached an international teaching milestone when Associate Professor Christy Collis from the Creative Industries Faculty became the university's 500th staff member recognised as a Higher Education Academy (HEA) fellow.

The HEA is based in the United Kingdom and awards fellowships internationally to candidates who meet its effective teaching and learning support benchmarks.

2017

3 Senior Fellows

15 Fellows

28 Associate Fellows

2018

1 Senior Fellows

3 Fellows

12 Associate Fellows

CURRICULUM CREDIT

Professional organisations support QUT by accrediting a broad range of courses and programs.

Course accreditation ensures that:

- national and international standards of safety, quality, and compliance are maintained within the industry
- best practice principles are widely distributed
- resources continuously develop and diversify through innovation.

2017 Accreditation

- Engineers Australia - Bachelor of Engineering (Honours) (Study Area A)
- Engineers Australia - Master of Professional Engineering (Study Area A) (provisional accreditation)

2017 Endorsement

- Australian Institute of Project Management – Master of Project Management

VICE-CHANCELLOR'S EXCELLENCE AWARDS

Academic Individual

Dr Pietro Borghesani
Science and Engineering Faculty
Research, Learning and teaching

Associate Professor Christy Collis
Creative Industries Faculty
Learning and teaching, Partnerships and engagement, Innovative and creative practice

Professor Uwe Dulleck
QUT Business School
Partnerships and engagement

Associate Professor Kathryn Fairfull-Smith
Science and Engineering Faculty
Research

Professor Linda Graham
Faculty of Education Research
Learning and teaching, Partnerships and engagement

Distinguished Professor Dietmar W. Hutmacher
Science and Engineering Faculty Research
Leadership

Sessional Academic Individual

Sarah Barns
Science and Engineering Faculty
Learning and teaching, Innovative and creative practice, Influence on work culture or climate

Sharron Genrich
QUT Business School
Learning and teaching

Professional Individual

Michelle Gane
Institute for Future Environments
Partnerships and engagement

Ian Mellor
Institute of Health and Biomedical Innovation
Client focus

Julie-Anne Sully
QUT Business School
Partnerships and engagement

Joanne Venturato
Division of International and Development
Partnerships and engagement, Client focus

Geoff Woods
Division of Finance and Resource Planning
Partnerships and engagement, Client focus, Community Partner Individual

Jeremy Hayllar
BDO Australia
Community partnership

Academic Team

AMPhilanthropy
QUT Business School - Ingrid Larkin, Professor Gayle Kerr, Associate Professor Wendy Scaife, Dr Louise Kelly
Partnerships and engagement, Innovative and creative practice

Mixed Team
Children's Vision Team Faculty of Health
Faculty of Education - Dr Alexander Black, Dr Sonia White, Professor Joanne Wood, Dr Shelley Hopkins Research

Community Partner Team

The Smith Family
Alan Le May, Sarah Gregory, Wendy Gernhoefer, Mandy Breese, Anthony Pfingst
Community partnership

Sessional Academic Team

Fashion Diplomats
Creative Industries Faculty
Carla van Lunn, Melanie Finger Learning and teaching

The David Gardiner QUT Teacher of the Year Award

Associate Professor Jennifer Firn
Science and Engineering Faculty

Associate Professor Timothy Moroney
Science and Engineering Faculty

PERFORMANCE

Student leadership.

QUT STUDENT LEADERSHIP EXCELLENCE AWARDS

Kindler Medallists Nicholas Sterkenberg (left) and Kaitlyn Lyons (right) with Science and Engineering Faculty Executive Dean, Professor Gordon Wyeth (middle).

Student Leadership Awards

QUT students are leaders on campus as well as in local, national and international communities. Each year QUT recognises the leadership at the Student Leadership Awards ceremony.

The awards include:

- one QUT Alumni Student Leader of the Year Award
- up to nine Student Leadership Excellence Awards
- special Excellence Awards, given at the discretion of the judging panel.

Nine leaders received awards in 2017, including four from the Science and Engineering Faculty.

Julian Loh	Bachelor of Engineering (Honours)
Josh Loyd	Bachelor of Engineering
Damien Slinger	Bachelor of Engineering (Mechanical Engineering and Project Management)
Timothy Hui	Bachelor of Business and Bachelor of Engineering (Honours)
Fred Duku Silver	Bachelor of Business and Bachelor of Laws (Honours)
Nalongded Luanglath	Bachelor of Business
Ria Bhagat	Bachelor of Journalism and Bachelor of Laws
Chenoa Masters	Bachelor of Education (Secondary)
Kristy Winter	Masters of Applied Science by Research in Health

All currently enrolled QUT students who have displayed service to the university and community are eligible for these annual awards.

John Ernest Kindler Legacy

QUT awards the Kindler Medal annually to outstanding engineering students. The award honours the leadership legacy of John Ernest Kindler, who was dedicated to advancing the engineering profession.

2017 Kindler Medallists:

Dean's Scholar Nicholas Sterkenburg
Bachelor of Engineering (Electrical)

Dean's Scholar Kaitlyn Lyons
Bachelor of Engineering (Mechatronics)

FUTURE LEADERS
IN STEM

In February 2018, 26 students were inducted into the Science and Engineering Dean's Scholars Program at QUT, which nurtures leadership potential among high academic achievers.

During the inaugural two-day camp, coaches challenged students' future leadership ideas and helped them shape plans to achieve aspirational goals.

The leadership program is open to high academic achievers with an existing merit scholarship and who study within a course offered by the QUT Science and Engineering Faculty.

Program sponsors, including AMPC, Bechtel, Boeing, Energex, Technology One and the Australian Centre for Robotic Vision, provide students with access to industry and research leaders in STEM, as well as opportunities to engage with the key challenges industries face now and into the future.

WINNING TENDER TO DELIVER WESTPAC YOUNG TECHNOLOGIST SCHOLARSHIPS UNTIL 2024

QUT is one of only five partner universities to offer Westpac Young Technologist Scholarships from 2019 to 2024.

Following a review of partnerships and a tender process involving more than 25 universities, Westpac Bicentennial Foundation CEO Susan Bannigan confirmed QUT as a university partner.

The review coincided with the expiration of three-year partnerships with 11 universities to offer the scholarships throughout Australia.

QUT Westpac Young Technologist Scholars

Seven QUT students received Young Technologists Scholarships from the Westpac Bicentennial Foundation in 2017 as part of a program to foster generations of innovators.

They were among 35 undergraduate students across 11 partner Australian universities to receive one.

The scholars receive support so they can strengthen Australia's pool of local talent and build a growing cohort of technology-literate future leaders.

Each scholar receives $5000 per year for up to five years of study. They are provided access to networks and practical learning experiences, and the opportunity to apply for Westpac's summer and winter technology internship programs.

Students also gain lifelong membership to the growing Westpac 100 Scholars Network, which gives them ongoing access to networking and collaboration opportunities.

2017 scholars

Vanessa Li	Bachelor of Engineering (Honours)/ Bachelor of Information Technology
Kanupriya Agarwal	Bachelor of Information Technology/ Bachelor of Mathematics
Maria Vargas Duque	Bachelor of Engineering (Honours)/ Bachelor of Information Technology
Niamh Conway	Bachelor of Business/ Bachelor of Information Technology
Riva Mendoza	Bachelor of Information Technology/ Bachelor of Mathematics

2018 scholars

|	
Julia Casa	Bachelor of Information Technology/ Bachelor of Mathematics
Sonal Singh	Bachelor of Information Technology/ Bachelor of Business
Sophie Jones	Bachelor of Games and Interactive Environments
Isabelle Miller	Bachelor of Information Technology
Abimbola Agbejule	Bachelor of Laws (Honours)/ Bachelor of Information Technology
Samantha Swift	Bachelor of Engineering (Honours)/ Bachelor of Information Technology
Aisha Darmansjah	Bachelor of Science/Bachelor of Games and Interactive Environments

International Merit Scholarships are awarded based on academic excellence. The number of scholarships awarded to the QUT Science and Engineering Faculty is a reflection of a rise in the quality of international student applications.

International students

2016	688
2017	797

International Merit Scholarships

2016	51
2017	80
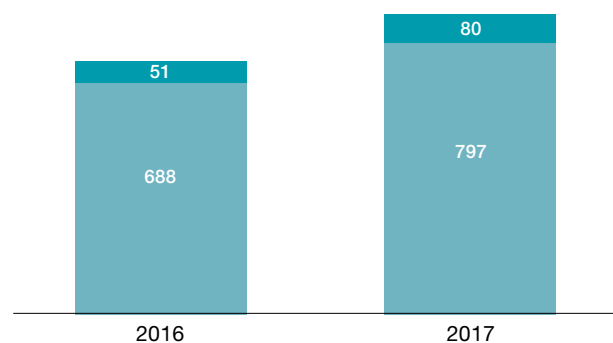
Boeing Event Day I: Boeing director of Starliner Crew and Mission Systems and a former NASA astronaut, Chris Ferguson visited high school and university students at QUT to talk about the future of STEM applications.

What students do outside the lecture rooms is just as important in shaping their skills and mindset as what they learn inside.

To help develop highly-skilled, enterprising graduates capable of thriving in a changing and complex world, QUT organises and supports a range of extra-curricular activities.

Job ready by graduation

- Future You – helping first and second year engineering, mathematics and IT students create their future career from their first year, providing information about how they can boost employability and be job-ready by the time they graduate.
- IT and Games Showcase (final year capstones) – holding demonstrations of the best polished and published games created by Games and Interactive Entertainment students, and an opportunity for industry to meet future graduates.
- Student Catchment Immersion Project – offering volunteer experiences and workshops to increase connectedness between students and community groups in Brisbane catchments.

Industry insights and connections

QUT understands one of the best ways to tailor tertiary curriculum to the future needs of industry is to work with professionals in the field.

In 2017 QUT hosted campus events with industry leaders including former astronaut and Boeing's director of Starliner Crew and Mission Systems Chris Ferguson, BMW vice-president Volker Richter, and QUT alumni including Facebook engineering director Joel Pobar and Ezidebit creator Michael Demspey.

Events included:
- Experience the Future with Boeing
- Elevation – Engineers Australia event for final year engineering students
- Not a Death Star – Consult Australia's International Women's Day event showcasing female built environment professionals
- Student club-hosted activities – Women in Workforce, Droid Racing Challenge, robotics workshops, Life as a Developer lecture series, Industry networking nights, mentoring workshops and hackathons
- Engineering, Construction and Planning Careers Day – engineering student clubs in partnership with the QUT Science and Engineering Faculty
- Project Management Pilot Program
- GEMS – peer-to-peer mentoring
- Major selection workshops.

BUILDING ASPIRATIONS

Inspiring students to build their STEM literacy and aspire to university-level education.

~3K

More than 3000 students from South East Queensland schools participated in science and engineering activities hosted by QUT on its Brisbane campuses.

1.2K+

More than 1200 school students participated in science and engineering-related activities hosted by QUT student clubs.

QUT is committed to inspiring the next generation of leaders by creating hands-on experiences that excite and enthuse students to pursue science, technology, engineering and maths (STEM) studies and careers.

2017 STEM events offered by QUT in partnership with external organisations included:

- Power of Engineering
- QMEA
- Re-Engineering Australia Foundation
- Queensland Spatial Information Council
- The Engineering Link Group
- Science and Engineering Challenge Council
- SheFlies
- Wonders of Science
- Boeing
- Transport and Main Roads
- SEQ Water.

www.qut.edu.au/study/stem-for-schools

Woodford State High School students in the 2017 Caboolture Science and Engineering Challenge, organised and managed by QUT.

F1 in Schools™ Queensland state final hosted by QUT featured guest judge and mechanical engineering alumnus Mark Dutton. Mark is the motor racing engineer and team manager of Triple Eight Race Engineering, which races Holden cars in the Supercar Championships.

WIDENING OUR STEM REACH AND BUILDING ASPIRATION

WINTER SCHOOL STRENGTHENS DATA SCIENCE FOUNDATIONS

11K+

More than 11,000 primary and high school students took part in a hands-on Extreme Science Van workshop in their school. Workshops are run by our student ambassadors.

10K+

More than 10,000 students, teachers, parents and community members participated in other Widening Participation activities run by the Science and Engineering Faculty in schools or on QUT campuses.

QUT is dedicated to increasing enrolments from students who may not feel that they have the opportunity to study at university.

The Widening Participation Program (WPP) works with under-represented school groups to build aspiration for university study, particularly in the fields of science, technology, engineering and maths (STEM).

QUT works in partnership with schools and communities through a wide range of outreach, admissions and support programs to increase aspiration, interest and access to post-school study.

The WPP team also aims to build confidence for teachers to incorporate STEM into their teaching through professional development opportunities.

With funding from the Australian Government's Higher Education Participation Program (HEPP) since 2010, QUT focuses efforts on partner schools in the North Brisbane and Caboolture area.

In 2017 almost 22,000 students, teachers, parents and others took part in science and engineering activities delivered by QUT on its campuses or in schools.

- **Extreme Science Van** – free science and engineering workshops funded by HEPP and delivered by the Science and Engineering Faculty.

- **National Science Week** – events and activities in Australia's annual celebration of science and technology.

- **Excellence/Transition Days** – workshops for Year 6 students, hosted by local secondary schools, that get kids excited about studying STEM subjects in high school.

- **Explore Uni** – encouraging interest through opportunities for Year 6-12 students to explore university from their school or on the QUT campuses.

- **Other activities** – open to all community, parents, teachers and students.

www.qut.edu.au/study/stem-for-schools/widening-participation

KEY CONTACT

Professor Ian Turner
i.turner@qut.edu.au

Seventy-five national and international graduate students participated in the Australian Mathematical Sciences Institute (AMSI) Winter School hosted by the QUT School of Mathematical Sciences School in 2017.

Directed by Professor Ian Turner and themed Computational Foundations of Data Science, a number of high-profile guest lecturers presented short courses, including Fields Medal winner Professor Sir Timothy Gowers.

The AMSI Winter School is a two-week residential program for graduate students, postdoctoral fellows and early-career researchers in the mathematical sciences and cognate disciplines, providing the opportunity for participants to expand their skills and build collaborative networks with their peers.

Below: Professor Ian Turner welcomes participants to the 2017 AMSI Winter School on Computational Foundations of Data Science, hosted by QUT. Credit: Patrick Hamilton Photography.

DEMYSTIFYING STEM

Encouraging community participation.

QUT partnered in the World Science Festival Brisbane (WSFB) held at Brisbane's Cultural Precinct from 22–26 March 2017.

The WSFB was an important success for science and Brisbane, attracting a stellar line up of scientists and a series of thought-provoking events.

Attendance was estimated at 182,000 with around 62,000 people participating in the Street Science! activities 25–26 March.

180K+ people attended World Science Festival activities, including those presented by QUT.

Below: Street Science at the World Science Festival Brisbane.

QUT took its STEM activities to Street Science!

- **Roboticist's Apprentice** - Workshops with Professor Jonathan Roberts and Dr Jared Donovan.
- **Brain Food Breakfast** - Biofabrication with Associate Professor Mia Woodruff.
- **Science Gets Social** - Mathematics in Movies with Associate Professor Michael Milford.
- **Frankenstein Anxiety: Robotics and the Replacement of Ourselves** - Robots and the Replacement of Ourselves with Professor Peter Corke.
- **Automated Autos: The Future of Driverless Driving and Drones** - Panel discussion with Professors Belinda Bennett and Jonathan Roberts.
- **Water Talks** - The Inconvenient Truth of Bottled Water with Associate Professor Gary Mortimer.
- **Science and Faith** - A Comfortable Coexistence with Professor Peter Bruza.
- **When Science Meets Art** - An Enduring Entanglement with Professor Judith McLean.
- **Street Science!** - Showcasing Science with PhD student Jesse Allen.
- **Street Science!** - Free fun at the QUT tent, Reefs Alive tent and the Connect with Water tent.

UAV CHALLENGE 2017

In 2014, *Team CanberrraUAV* won the original UAV Challenge Outback Rescue, seven years after the challenge to locate Outback Joe and autonomously deliver him sustenance was first tabled.

Teams worldwide repeatedly competed for the $50,000 prize.

The 2017 event targeted high school teams only.

The 2018 UAV Challenge will launch the Medical Express open competition to run in conjunction with its Airborne Delivery Challenge for high school students.

- **UAV Challenge Medical Express** – a competition to demonstrate UAV autonomy for medical sample retrieval and medical delivery, open to adult teams worldwide.

- **UAV Challenge Airborne Delivery** – a competition to demonstrate radio-controlled aircraft with novel delivery mechanisms for medical payload delivery, open to high school students worldwide.

The UAV Challenge competitions are co-organised by QUT and Data61 (CSIRO), and sponsored by Queensland Government, Boeing, Insitu Pacific, Northrop Grumman, Lockheed Martin and Defence Science and Technology Group and The Mathworks.

For the first time ever, two high schools won the UAV Challenge Airborne Delivery Challenge in 2017.

Held annually, the challenge tasks high school students to develop an unmanned airborne vehicle (UAV) system that drops an epipen (impact monitor) to fictional lost bushwalker Outback Joe.

Winning teams *Cheeky Mangoz* from Toowoomba Christian College and the *Calamvale Predators* from Calamvale Community College received $3500 each, an equal share of the combined first and second prizes.

Cheeky Mangoz also received the $2000 Rookie Award.

Third placed Air Iris from Mueller College in Rothwell, Queensland, won $1000.

Air Iris was also the first and only team to use a winch to lower the medical package to Outback Joe.

The UAV Challenge is designed to push the boundaries of UAV technologies and demonstrate their potential for civilian applications, particularly those that will save lives.

Aero modellers, university students and high school students from around the world develop and enter novel and cost-effective solutions.

Below: Teams and mentors in the 2017 Queensland Government Airborne Delivery Challenge organised by QUT and CSIRO. Credit: Adam Harper.

ROBOTRONICA

Robowars rumbled at the Australian Robowars National Championship. Credit: Anthony Weate

Below: Artist-astronaut Dr Sarah Jane Pell entertained audiences with a live performance blending VR mapping of historical lunar imaging data and augmented reality artefacts from a real spacewalk simulation on earth called Project Moonwalk. Credit: Anthony Weate

QUT's renowned biennial robotics festival, Robotronica, returned in 2017, attracting a record 22,000 people.

The festival revealed the latest advancements and innovations in robotics and interactive design, including an international exhibition exploring AI and creativity, W*hy future still needs us: AI and humanity.*

Robot fighting enthusiasts travelled from around the country to compete in the Australian Robowars National Championship, the biggest robot combat competition in Australia.

International speakers included American roboticist and roboethicist from the Georgia Institute of Technology, Professor Ron Arkin, who spoke on *Robots Ethics and Intimacy and Robots that Need to Mislead.*

Extreme performance artist, Dr Sarah Jane Pell gave a mixed reality keynote that combined astronautics, occupational diving, HCI media design, biotechnology, body performance and exploration.

Her live event, *The Agency of Human-Robotic Lunatics,* used an autonomous subject-tracking robotic camera system called the Cinema Swarm, to blend performance with VR mapping of historical lunar imaging data, and augmented reality artefacts from spacewalk simulation Project Moonwalk.

The Project Moonwalk consortium developed and tested technologies and training procedures for future missions to the Moon and Mars.

WORLD OF DRONE CONGRESS

QUT was principal academic sponsor of the inaugural World of Drones (WoDC) held Brisbane in 2017.

More than 630 international delegates attended the congress, which featured more than 30 exhibitors from Australia, China and Japan.

Leading robotics and autonomous systems researchers from QUT featured in the program including Professor Tristan Perez, Professor Des Butler and Associate Professor Felipe Gonzalez.

The WoDC program also included the launch of Australia's first state-wide Drones Strategy by the Premier of Queensland, and the first Australian National Drone Safety Forum.

QUT participation in the WoDC continued in 2018.

www.worldofdrones.com.au

PHILANTHROPY TO SHAPE THE FUTURE

Every gift has an impact. Gifts to QUT change people's lives through education, research and community service.

QUT was honoured to receive support from families, foundations, organisations, companies and the community to continue science and engineering legacies throughout 2017.

- The **Siganto Foundation Medal endowment fund** reached $250,000 with the foundation's final gift. Through investment earnings, the annual Siganto Foundation Medal of $10,000 will now be awarded in perpetuity.

- A $5000 **John F Lynch Scholarship** was awarded to support a student studying civil and environmental engineering in 2017. Like the Siganto Foundation Medal, the scholarship was funded through endowment earnings.

- QUT alumnus, Maria Barrett made a gift to establish new **Widening Participation in Science Bursaries** of $1000 each to support students from Widening Participation Program partner schools who enrol in science degrees at QUT.

- PhD student Mardi McNeil from the School of Earth, Environment and Biological Sciences was awarded the **Laurie Cowled Learning Potential Fund PhD Scholarship** of $10,000 for the second year. This is the first time the scholarship has been awarded to the same student twice.

- The IEEE granted $12,500 to the **QUT Robot Academy** to help continue to offer free robotics courses.

- **Google** granted $75,000 to support Dr Niko Suenderhauf from the School of Electrical Engineering and Computer Science in the Google Robotic Vision Perception Challenge.

- **Merchant Charitable Foundation** provided a gift of $150,000 to support Dr Anders Eriksson's project, *An Artificial Intelligence Platform for Early Skin Cancer Diagnosis.*

www.qut.edu.au/engage/giving

Dr Jake Whitehead won the 2017 Siganto Foundation Medal for outstanding research. He said he intends to further his civil engineering research efforts in Europe and bring learnings back to Australia to affect positive change within local transport systems.

NURTURING ENTREPRENEURIAL SPIRIT

Popgun team members, computer science graduate Adam Hibble (left) and business and law student Jack Nolan (right).

POPGUN'S ALICE HIT THE TOP NOTE

KEY CONTACT

Brent Watts, Director of Ventures and Investment, QUT bluebox
startup@qutbluebox.com.au

A team that created a music-composing artificial intelligence called ALICE claimed QUT's top innovation challenge and a $50,000 prize in 2017.

Team Popgun, which includes computer science graduate Adam Hibble and business/law student Jack Nolan, won the QUT bluebox Challenge, a business pitch showcase for QUT graduates, students and staff.

The winners said their prize money would go towards growing the engineering team building ALICE, and visiting the United States to forge partnerships with tech music companies.

"ALICE can play and compose piano pieces and respond to a human musician by reworking melodies, creating new musical phrasing or suggesting chord progressions."

"The aim is to expand this capacity to other instruments and to develop the technology to become an essential creative tool and source of inspiration for musicians and producers.

"It could also be a tool for those learning music. Instead of practising piano or guitar alone with sheet music, you can practice with ALICE."

The three winning start-ups, and other four finalists in the annual $500,000 challenge shared in a range of services, investment and accelerator program prizes.

QUT bluebox is the university's innovation, venture and investment company, helping commercialise QUT ideas and research.

Top: 2017 QUT bluebox Challenge winners (left to right) Adam Hibble (Popgun), Carly Brown (UNE PIECE), Jack Nolan (Popgun), Ruth Stephensen and Scott Thomas (Creatively Squared).

EZIDEBIT CO-FOUNDER IS AN OUTSTANDING ALUMNUS

Ezidebit co-founder Michael Dempsey won the 2017 Outstanding Alumni Award (Science and Engineering Faculty).

Ezidebit co-founder Michael Dempsey won the 2017 Outstanding Alumni Award (Science and Engineering Faculty) at the annual QUT Outstanding Alumni Awards.

Mr Dempsey graduated from then QIT with a Bachelor of Engineering (Mechanical) in 1987 and started his career as a quarry engineer before realising an interest in developing computer systems.

With a career spanning real estate, childcare and engineering, Mr Dempsey used his programming skills to become an entrepreneur.

While building two childcare centres in Brisbane with his partner, he realised the financial cost of fees in arrears and co-founded Ezidebit, which resulted in 90 per cent of fees paid on time by his businesses.

In 2014, Mr Dempsey sold Ezidebit for $305 million, highlighting his business acumen as one of Queensland's leading entrepreneurs.

Mr Dempsey continues to pursue a number of business interests as director of Pipeline Capital and co-owner of the Normanby Hotel, OntheHouse real estate website and cloud-based property management software company, Console.

SPEAKING THE RIGHT LANGUAGE FOR MICROSOFT & FACEBOOK

ACCELERATING ADOPTION OF EARLY-STAGE TECHNOLOGIES

At just 33 years of age, Michael Brett has made quantum leaps in the field of avionics and computing and, in recognition, received the 2017 QUT Young Innovation and Entrepreneurship Award.

Mr Brett is an expert in complex systems with extensive experience in developing and accelerating adoption of early-stage technologies and delivering projects in aerospace, defence, high-performance sports and data analytics.

He graduated from QUT in 2005 with a Bachelor of Engineering (Aerospace Avionics) and in 2013 completed an Executive Master of Business degree in Complex Project Management.

As co-founder and CEO of QxBranch, Mr Brett created a leading US-Australian company with world-class expertise in systems engineering, advanced data analytics, machine learning, quantum computing and risk analysis across sectors.

The company mission is to solve difficult analytical problems with advanced technology. It uses quantum computing to train machine learning algorithms to find patterns in complex datasets.

2017 QUT Young Innovation and Entrepreneurship Award recipient and co-founder and CEO of QxBranch Michael Brett.

About the Outstanding Alumni Awards

The Outstanding Alumni Awards recognise outstanding graduates from QUT and its predecessor institutions who have displayed exceptional professional, academic or research achievements and contributions to the community.

2017 QUT Innovation and Entrepreneurship Award recipient and Facebook engineering director Joel Pobar.

Joel Pobar's command of computer language helped him land jobs at Microsoft and Facebook.

In recognition of his expertise in computing and technology, Mr Pobar won the Innovation and Entrepreneurship Award at the 2017 QUT Outstanding Alumni Awards.

While studying at QUT, Mr Pobar took a computer compilers course which led to his decision to specialise as a compiler and in program language development.

He graduated in 2002 with a QUT Bachelor of Information Technology (Hons) majoring in computer science.

Mr Pobar moved to the US, first working with Microsoft in Seattle.

Facebook headhunted him in 2011 to develop a brand new programming language and runtime system called HHVM, the Hip Hop Virtual Machine, which is a virtual machine for PHP code.

Mr Pobar helped drive mobile platforms and enhanced connectivity, which helped Facebook unlock new advertising opportunities.

As Facebook's engineering director, Mr Pobar helped transform the company and facilitate its global dominance.

He manages 100 people across software teams in San Francisco, Seattle, New York and London.

1.5B FRUIT NINJA DOWNLOADS PUT HALFBRICK INTO THE QLD BUSINESS LEADERS HALL OF FAME

OUR PARTNERS

KEY CONTACT

Alumni and Development Office
alumni@qut.edu.au

Fruit Ninja by Halfbrick has achieved more than 1.5 billion downloads.

Halfbrick Studios, video game developer and creator of the Fruit Ninja app, was inducted into the Queensland Business Leaders Hall of Fame in 2017.

At more than 1.5 billion downloads, Fruit Ninja is the world's second most downloaded app of all time.

CEO Shainiel Deo studied information technology at QUT and founded Halfbrick with a group of friends.

Brisbane-based Halfbrick now also maintains operations in Sydney, San Francisco, Los Angeles and Spain.

The video game developer joined five other Queensland business luminaries which made their mark in diverse fields from health to engineering.

The Queensland Business Leaders Hall of Fame is a joint initiative between the QUT Business School, State Library of Queensland and Queensland Library Foundation.

It celebrates organisations and individuals who have enhanced the state's economy, social development and reputation, and is overseen by a governing committee of private and public sector representatives.

Our expertise in finding solutions to complex problems means that we deliver real-world results for our partners in industry and government.

qut.edu.au/engage

Corporations

Asahi Kasei Corporation
Aurecon Group Pty Ltd
Australian Meat Processor Corporation
Bank of Queensland
Bechtel
Boeing
Brisbane Airport Corporation Pty Ltd
Commonwealth Bank of Australia
Energy Queensland
Komatsu Australia Pty Ltd
LaManna Premier Group
Lendlease
Manildra
Mining3
Northrop Grumman
PwC Australia
Siemens
Southern Oil
Stryker Australia
Sumitomo Electric Industries, Ltd
Suncorp Group
Syngenta Australia Pry Ltd
Technology One

Foundations and Organisations

Bill and Melinda Gates Foundation
Engineers without Borders

Representative and Research Groups

Asset Institute
Cotton Research and Development Corporation
CRCSI (Spatial Information)
Hort Innovation
Lincoln University
Local Government Association of Queensland
Queensland Electricity Transmission and Distribution Group
Queensland Urban Utilities
Sugar Research Australia

Queensland Government

Department of Agriculture and Fisheries
Department of Education
Department of Environment and Science
Department of State Development, Manufacturing, Infrastructure and Planning
Department of Transport and Main Roads
Queensland Fire and Emergency Services

Australian Government

Australian Bureau of Statistics
Australian Centre for International Agricultural Research
Australian Institute of Marine Science
Australian Renewable Energy Agency
Defence Science and Technology Group
Department of Agriculture and Water Resources
Department of Defence
Department of Human Services
Department of Industry, Innovation and Science

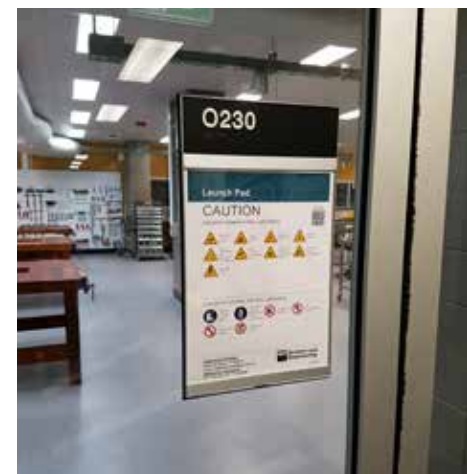# MAKERSPACE FOR CREATIVE SCIENCE AND ENGINEERING
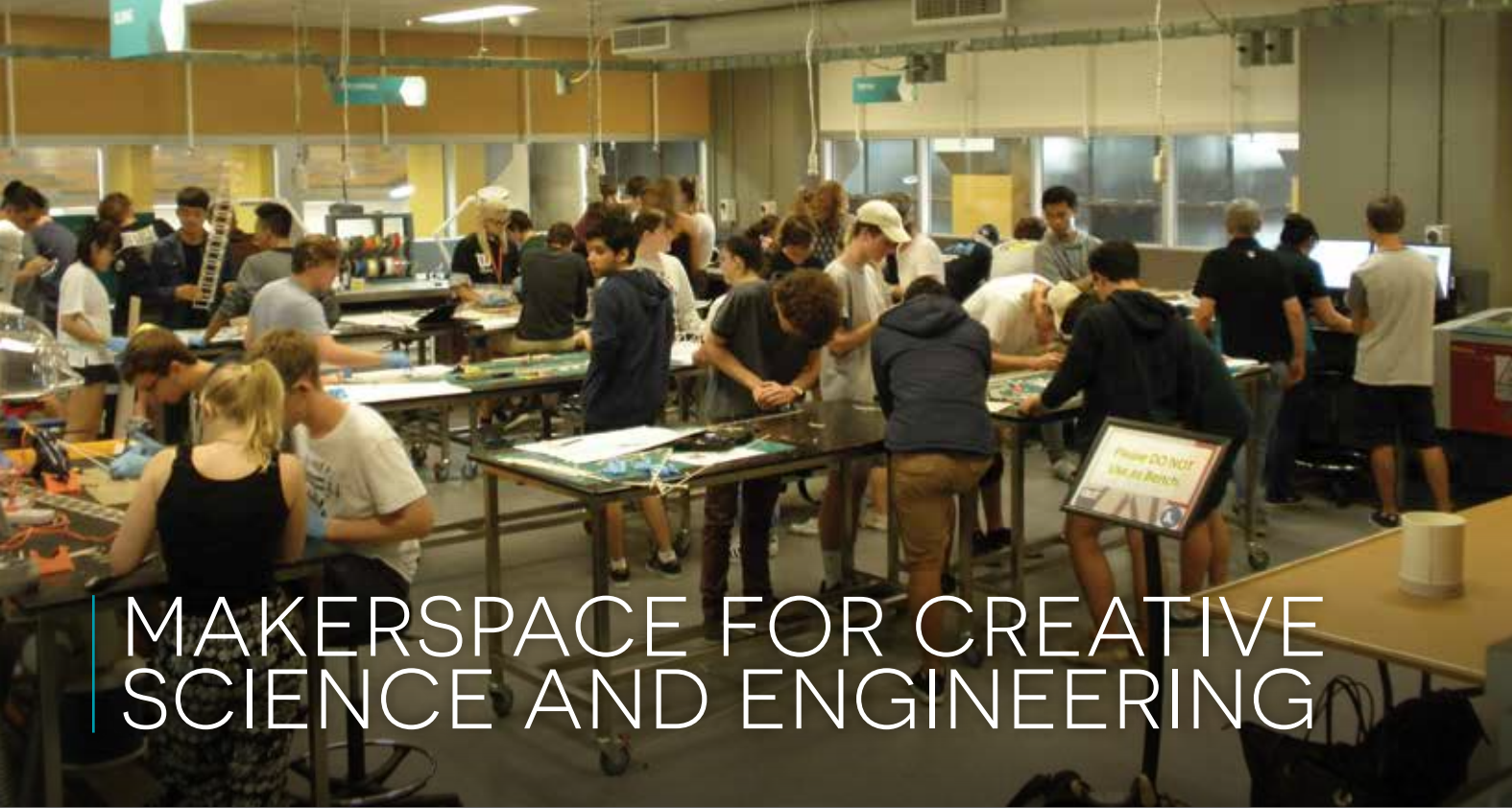
KEY CONTACT

Scott Abbett
s.abbett@qut.edu.au

QUT opened the makerspace, LaunchPad, to students and researchers of the Science and Engineering Faculty at QUT's Gardens Point campus in Brisbane.

LaunchPad is a hands-on fabrication facility designed to support teaching and research activities.

Users undertake a range of small-scale manufacturing tasks associated with academic units and project endeavours.

More than 2800 students have registered to use the makerspace, driven largely by the interrelationship of *LaunchPad* with specific teaching units targeting first year engineering cohorts, and robotic and design programs.

The fully supervised and stocked makerspace received more than 10,000 visits in its first three months of operation.

In 2017 the Association of Tertiary Education Management highly commended QUT for the development of *LaunchPad* in its award category for Excellence in Student Engagement, sponsored by Campus Living Villages.

More than just a workshop

LaunchPad is a curated space that differs from other makerspaces because students have a reason to use it, and clear direction and training.

QUT asked its unit coordinators what students were expected to build as part of their course then curated the space with suitable consumables and equipment.

LaunchPad addresses key issues of equity and equality within the university community by providing all staff and students access to the best equipment, resources and expertise to rapid-prototype projects from beginning to end.

All materials and equipment are provided free for undergraduate use. Other users, including postgraduate students and researchers, use the space and pay for consumables as required.

> Students can give their ideas physical form without needing off-campus access to an established workshop.

What's in *LaunchPad*?

- High-quality engineer's drill press.
- Scroll saw.
- Belt sander.
- Gluing stations.
- 6x 3D printers.
- 2x high-end laser cutters.
- 4x soldering stations.
- Multimeters.
- Oscilloscopes.
- Wide range of hand tools.
- Medium-scale metal and plastic forming tools.
- And more…

Safety first

Users are not expected to undergo days of training before use. Initial inductions can take less than an hour so that students can start their projects quickly.

Safety systems are robust yet easy to use, balancing what students want to make and what the university can provide with QUT obligations regarding working safely within the space.

Makerspace users undergo a three-stage induction to access equipment.

Online induction
- Theory test.
- Processes and procedures.

In-lab orientation
- Familiarisation.
- Work instruction review.

Induction for high risk activities
- Competency test.
- Drill, sander, scroll saw induction.

The course management platform, Blackboard, is used for student inductions and tracking student competencies.

Blackboard integrates community and information-sharing environments, announcements and training documents.

Enterprise is the future

Initial objectives focusing on student learning and self-fulfilment are fast being realised.

LaunchPad will expand its influence to include enterprise.

Enterprise is the entrepreneurial aspect of the 'maker' culture, transforming an idea into a prototype and pitching it to investors.

In the short term, QUT is now working on integrating use for engagement programs, such as those coming onto the campus to experience STEM.

Longer term, *LaunchPad* will be assessed to determine requirements for an expansion.

BOEING WAS RECOGNISED AS ORGANISATION OF THE YEAR

QUT awarded Boeing the Organisation of the Year Award for its long-standing participation in the Career Mentor Scheme.

Boeing's participation grew from four mentors in 2015 to 32 mentors in 2017.

Through the Career Mentor Scheme, QUT continued to develop strong relationships with organisations and individuals who consider mentoring a great way to invest in professional development and contribute to their community.

Associate Technical Fellow Brendan Williams accepted the award on behalf of Boeing.

Top (left to right): QUT Alumni Board member Andrew Quinn; Boeing Associate Technical Fellow Brendan Williams; QUT Vice-Chancellor (retired) Professor Peter Coaldrake AO.

QUT

The Queensland University of Technology (QUT) is a highly successful Australian university well-known as 'a university for the real world' because of our close links with industry and our relevant teaching and applied research.

Based in Brisbane, QUT has almost 50,000 students from Australia and other countries.

www.qut.edu.au

Science and Engineering Faculty

The QUT Science and Engineering Faculty comprises six schools which deliver a range of education and research outcomes to support economic, social and environmental advances through science, technology, engineering, mathematics, (STEM), and urban development fields.

Schools

- Chemical, Physical and Mechanical Engineering.
- Civil Engineering and Built Environment.
- Earth, Environmental and Biological Sciences.
- Electrical Engineering and Computer Science.
- Information Systems.
- Mathematical Sciences.

www.qut.edu.au/science-engineering

TOBACCO PLANTS AS LIFESAVERS: QUT PART OF EUROPEAN COLLABORATION

KEY CONTACTS

Professor Peter Waterhouse
peter.waterhouse@qut.edu.au

Dr Cara Mortimer
cara.mortimer@qut.edu.au

QUT became the sole international partner in a $10.5 million European project to develop new tobacco varieties as biofactories for pharmaceuticals and vaccines.

QUT is one of 18 partners in the four-year Newcotiana project to sequence the genome of Australian native tobacco plant *Nicotiana benthamiana* which will underpin project research.

Newcotiana is funded by the European Commission through its Horizon 2020 research and innovation program.

Molecular Genetics Professor Peter Waterhouse, from the Centre for Tropical Crops and Biocommodities (CTCB), and his team were invited to collaborate largely for their sequencing of the genome of *N. benthamiana.*

Research Fellow Dr Cara Mortimer, also from the CTCB, said the project aimed to develop an advanced 'toolbox' of plant breeding techniques for tobacco.

These tools would be used to create high-value, non-smoking tobacco varieties to become biofactories producing molecules and proteins for life-saving drugs and vaccines.

"This project looks to provide tobacco plants which are efficient biofactories and which can be farmed, providing an alternative to farming of traditional tobacco," Dr Mortimer said.

Known as the Pitjuri plant by indigenous Australians, *N. benthamiana* is considered the research 'lab rat' of the molecular plant world, used globally by geneticists as an experimental host in plant virology.

N. benthamiana is also increasingly becoming a biofactory for recombinant proteins for medicine, industry and research. It was used to produce ZMapp, the antibody cocktail administered during the 2015 Ebola outbreak, and is currently being tested for production of an array of pharmaceutical proteins, from viral vaccines to therapeutic treatments for breast cancer and non-Hodgkin lymphoma, autoimmune diseases and fungal infections.

Professor Waterhouse's team traced the history of the lab strain of the native plant and found it grows near the Western Australian and Northern Territory border. Its seeds were sent by an Australian scientist to America in 1939, passing from lab to lab ever since.

The native plant genome has nearly 60,000 genes, twice the number of an ordinary plant.

Professor Waterhouse said QUT researchers sequenced about 85 per cent of those genes and shared the information through an open source website. A further 11 per cent of the genes have been partially sequenced, while the remaining 4 per cent are yet to be identified.

"Collaboration in the Newcotiana project will allow us to have 100 per cent of the plant's genome sequenced," Professor Waterhouse said.

"If you have the whole genome sequenced, you know what you are dealing with, and you can achieve greater precision in the applications with that information."

Professor Waterhouse and his team have a collection of different, 'wild' *N. benthamiana* from around Australia, and have partially sequenced the genomes of these plants.

"We have discovered that there are even more genes represented in these 'wild' variants than in the lab plant," he said.

"We think there is a great untapped resource with these variants that offers even more possibilities."

Also part of the QUT's Newcotiana team with Professor Waterhouse and Dr Mortimer are Dr Hyungtaek Jung, Dr Michal Lorenc, Dr Julia Bally, Dr Fatima Naim, Dr Satomi Hayashi and Matthew Hodgett.

Professor Peter Waterhouse received a Prime Minister's Prize for Science in 2007 for his gene-silencing discovery with Dr Ming Bo, as members of the CSIRO Plant Industry team.

The scientists investigated the 'immune system' of plants with the aim of developing better ways to protect crop plants from viruses.

They found that plants have mechanisms to identify and cut up the double-stranded RNA produced by invading viruses.

The plants then bind these bits of alien RNA to an enzyme (a nuclease) which is able to locate and destroy the normal single stranded RNA of the virus.

The technology could be used to insert genes into plants that would protect them against multiple viruses.

The discovery found its way into wider application across the biological sciences and generated more than 100 patents between 1997 and 2007, and is helping scientists understand the workings of plant, animal and human genomes.

connect with us

QUT
Science and Engineering Faculty
2 George Street
GPO Box 2434
Brisbane QLD 2001
Australia

Phone   +61 7 3138 8822
Email   sef.enquiry@qut.edu.au
Website   www.qut.edu.au/science-engineering

Join us on social media by searching for
QUT Science and Engineering.

The LABS
Learning and Big Solutions (LABS) from the QUT Science and Engineering

Faculty
Read our stories online via **medium.com/thelabs**