

ingenuity/

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Global Inspiration

A dream to design and build social robots has taken student Anastasia Laczko around the world



THE UNIVERSITY
OF QUEENSLAND
AUSTRALIA

CREATE CHANGE



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Cover:

Anastasia Laczko at Deoksugung
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Welcome

Let me tell you about our University and our people. And how some things change, and how some never will.

For over 100 years, UQ has been a pioneer of research across Queensland, answering the important questions from how we should think about transdisciplinary design, or how we can fly at supersonic speeds, to how we can use humanoid robots to help children engage with Indigenous languages.

This University is the heart of education and research in the Sunshine State, and it is our students, staff and alumni who are the unchanging essence of our university.

To those who have become part of our community, UQ is where intellectual boldness, creative curiosity and technological abilities come to life.

And we do what we have always done: provide the platform to realise their potential and have the fearlessness and creativity to excel on a global stage.

We create opportunities to innovate with new technology and new ways of thinking, while blending experiences that enhance university life and learning.

We challenge and support our people to harness their remarkable skills and passion for making a better world for us all.

And we never forget their contributions, because every contribution forms an essential part of our story.

So no matter where you are today, you've never really left UQ, because UQ never leaves you.

Professor Vicki Chen

Executive Dean // Faculty of Engineering, Architecture and Information Technology



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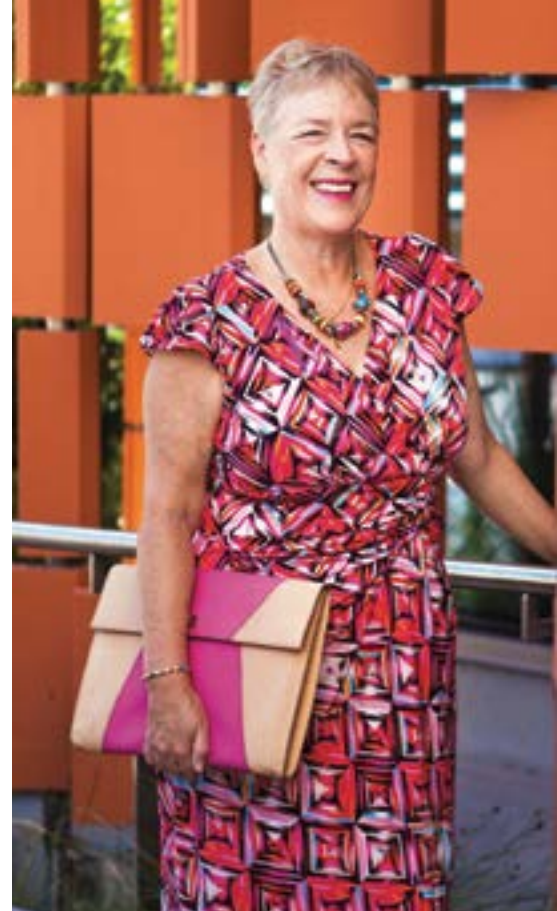
REUNITE WITH YOUR MATES

Find out about upcoming reunions in 2020 or learn about how you can help to organise a class reunion by visiting alumni.uq.edu.au, or contact the Alumni Engagement team on uqalumni@uq.edu.au or **+61 7 3346 3166**.



EVENTS IN 2020

Find out about the events we have planned for 2020 by visiting eait.uq.edu.au/events



UQ Women

recognised in Queen's Birthday Honours

A sustainable energy expert and distinguished alumni were among the roll call of University of Queensland community members recognised in the 2019 Queen's Birthday Honours.

Professor Peta Ashworth, UQ's Chair of Sustainable Energy Futures and coordinator of the Master of Sustainable Energy program, received national recognition for her work, being awarded an Order of Australia Medal (OAM) for her service to science in the field of sustainable energy.

Outstanding alumna Kathryn Fagg (Bachelor of Engineering (Honours) '82, Doctor of Chemical Engineering honoris causa '16) received an Order of Australia (AO) for her distinguished service to business and finance, to the central banking, logistics and manufacturing sectors, and to women.

UQ Senator and champion of industry and global female empowerment Kathy Hirschfeld (Bachelor of Engineering (Chemical Engineering) '82) was appointed a Member of the Order of Australia (AM) for significant service to engineering, to women, and to business.

A chemical engineering graduate, Ms Hirschfeld chairs the UQ Advancement Committee, is a former president of the UN Women National Committee Australia, and generously

supports a scholarship that encourages women to pursue engineering studies.

UQ Vice-Chancellor and President Professor Peter Høj AC said the awards were well-deserved recognition of extraordinarily talented individuals.

"It is wonderful to see the tireless efforts of those who have pushed the boundaries of discovery and industry rewarded with national recognition," Professor Høj said.

"Many other UQ community members have been named in this year's Queen's Birthday Honours and we congratulate them and celebrate their contributions."

"I have great admiration for our alumni, staff and students who continue to create positive change in society through their leadership, research, teaching and other accomplishments."

Image: (left to right) Professor Peta Ashworth, Kathryn Fagg, Kathy Hirschfeld.



A Wave of Success

UQ civil engineering researcher Professor Chien Ming Wang has had a stellar year in 2019, receiving esteemed awards and recognition within Australia and around the world.

Professor Wang was named a Fellow of the Australian Academy of Technology and Engineering in October, recognising his leadership in applying science, technology and engineering to solve real-world problems.

UQ Vice-Chancellor and President Professor Peter Høj AC said that as an Academy Fellow, Professor Wang had joined some of the country's most influential innovators.

"Academy Fellows are elected on the basis of their expertise and translation of deep research into real-world outcomes," Professor Høj said.

"Professor Wang is considered one of the best civil engineering researchers in the world – ranking among the best in the latest Stanford University Worldwide Survey.

"He has almost 600 publications and more than 16,000 citations to his name and is well known for his work in offshore engineering and floating structures on a scale large enough to support urban populations."

On top of these honours, Professor Wang was also awarded the prestigious 2019 JN Reddy Medal for his

original and sustained contributions to the advancement of structural mechanics.

A globally renowned expert in 'very large floating structures', he believes that establishing well-engineered floating communities could be the answer to many of humanity's environmental and social issues.

Professor Wang holds multiple international patents on a variety of designs for floating structures, including a bunker facility and breakwater windbreak structures, as he works to make this dream a reality.

"Earlier this year I was appointed the leader of the research programme on offshore engineering and technology of the Blue Economy Cooperative Research Centre," he said.

"We have received \$329 million from the Australian government and 40 other industry partners to conduct research on sustainable seafood production and renewable energy over 10 years.

"Through this research, we hope to deliver innovative designs of floating offshore fish farms for the Australian aquaculture industry."

"In the coming years, my research team and I also hope to develop cost-effective solutions to protect fragile shorelines and coastal infrastructure from severe storms unleashed by climate change."

Exploring New Frontiers

in the workshops of UQ



The Advanced Prototyping Workshop at The University of Queensland is an engineer's wonderland.

Tucked away on the bottom level of the iconic Advanced Engineering Building by the UQ Lakes, the workshop is home to an Aladdin's cave of tools, machinery and opportunity.

Gaining a spot on the elite team of six is no easy feat – UQ is in the top 50 in the world, after all, and there's only one Advanced Prototyping team.

The small group of technical and trade-qualified specialists have come from an array of design and fabrication backgrounds. They're tool makers, CNC machinists, plastic injection specialists, wood machinists, and mechanical whizzes.

The team spend their days grinding, tweaking, honing and polishing some of the most cutting-edge engineered designs out there.

Professor Michael Smart from the UQ Centre for Hypersonics is researching and developing air-breathing

scramjet engines for travel into space, and he's got a secret weapon up his sleeve. His secret weapon's name is Gary Manning (pictured below) and Gary is legendary for his seamless work on a 5-axis CNC machine.

"The scramjet engine models we test are very complex – we're performing aerodynamic experiments in our T4 shock tunnel, which can recreate the exact conditions of hypersonic flight in the upper atmosphere, so of course we require extreme precision on our prototypes," Professor Smart said.

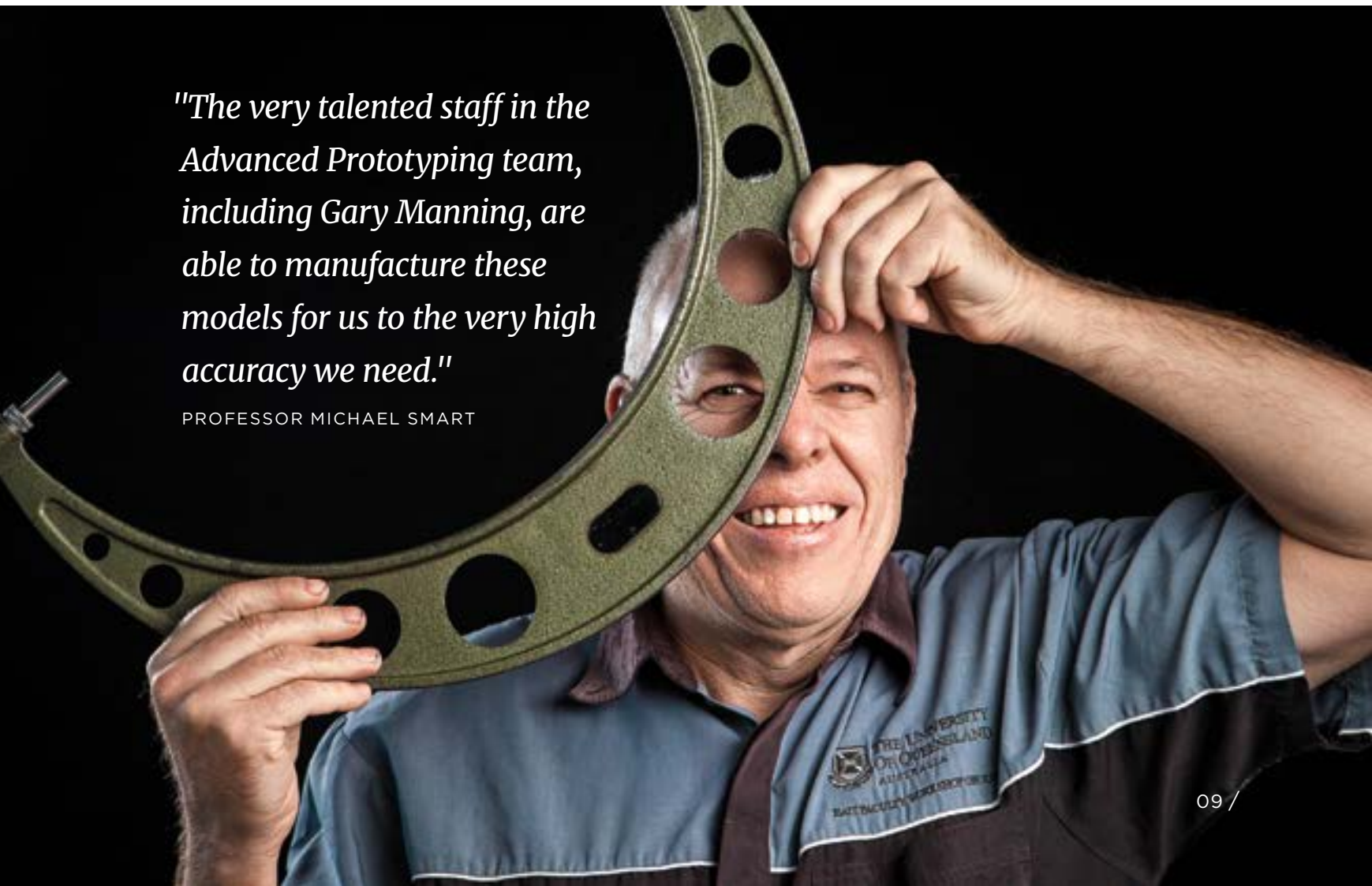
"The very talented staff in the Advanced Prototyping team, including Gary, are able to manufacture these models for us to the very high accuracy we need.

"When we as the research team are designing our scramjet engine models, we can talk with the workshop staff to work through issues as they arise and collaboratively design models that are easier to manufacture and, therefore, less expensive."

The Advanced Prototyping team will tell you it's a challenging, but very rewarding, task helping to create new kinds of rocket engines.

"The very talented staff in the Advanced Prototyping team, including Gary Manning, are able to manufacture these models for us to the very high accuracy we need."

PROFESSOR MICHAEL SMART





UQ Innovate

In August 2019, UQ launched the biggest university makerspace in the southern hemisphere, 'UQ Innovate'.

The workshop houses advanced manufacturing and prototyping tools and machines, including 3D printers, vacuum formers, industrial robots and waterjet cutters, among a raft of other facilities.

Technical and trade-qualified staff are on hand to assist students and researchers in bringing their ideas to life.





*“Seeing students
get this excited
about design and
manufacturing also
gives me energy to
keep pushing forward
with new ideas.”*

GARY MANNING

“Professor Smart’s latest scramjet engine design was really fun to help create,” said Mr Manning.

“To know he was taking it with him to Oxford to work with the best aerospace researchers in the world is pretty exciting - and we’re playing a role in that.”

“I love working in this team, where everyone is focused on absolute precision and working towards bigger goals.”

The Advanced Prototyping team doesn’t just work with researchers, the team also works with students on design and prototyping projects – and since the recent launch of Australia’s biggest university makerspace ‘UQ Innovate’ on campus, the team is only getting busier.

“We’re working on all sorts of projects with students and academic staff – from omni-directional wind turbines for energy generation, to race cars for UQ’s student Formula SAE racing team – there’s always something new and interesting to get stuck into.”

UQ Space rocketing ahead

UQ Space, the University’s student rocketry team, currently holds the number one ranking in Australia for competitive university rocket launches.

The rocketry team works very closely with UQ’s workshop team to produce their winning designs.

Managing Director of UQ Space, mechanical engineering and political science student Myrthe Snoeks said her team had been able to achieve a huge amount in the past year, thanks to the support and facilities available at UQ.

“UQ is definitely not just about books and study – we have the chance to design, build and create to our hearts’ content,” said Ms Snoeks.

“The rockets we’ve built, called Athena and Minerva, are 2090 millimetres and 2650 millimetres long, respectively.

“Each carries a four-kilogram payload as close as possible to their target altitudes of 10,000 and 30,000 feet, and reaches maximum speeds of Mach 1 and Mach 2.25.

“With the launch of the new makerspace this year, we have the tools we need to tackle even more exciting and challenging projects, with the aim to go further than any Australian university team has gone before.

“Our next goal is to send a student build rocket to 100-kilometres, passing the Kármán Line, and officially reaching space, and we will compete in the international Spaceport America Cup in the United States in June.”

And Gary and the team are ready to go.

“Seeing students get this excited about design and manufacturing also gives me energy to keep pushing forward with new ideas.”

Lunar Lodgings

Humans landed on the Moon 50 years ago, but what if they'd stayed? Master of Architecture students from The University of Queensland have imagined what life might be like today on the Moon if the Apollo 11 team had stayed there.



The 'Utopian Urbanism' design studio, a postgraduate course led by Senior Lecturer Dr Nicole Sully, explored possible scenarios for future cities amidst a range of global issues, like global warming or political upheaval.

In Semester 1, 2019, the 22 students enrolled in the studio were offered the opportunity to design a lunar colony.

Throughout the semester students developed and tested radical and imaginative ideas for human settlements in outer space.

Among them, Soobeen Jo's vibrant colony, named 'Dalnara' (pictured below), projected an out-of-this-world nature and gourmet destination. The scheme was organised around a series of vertical gardens, including one with heavenly salad bar walls, that were made possible by the Capital Moon's microgravity.

Ryan Browne imagined an alternative dystopian scenario involving a Russian oligarch with pharmaceutical interests, who, having discovered the Apollo 11 landings to have been faked, secretly colonised the far side of the Moon, building a pharmaceutical laboratory beyond the eyes of Earth.

Another student, George Stathis, even delved into what an Olympic Games might look like on the Moon (concept pictured on opposite page). George said he said he really had to think outside the box to develop his idea.

"Designing a stadium in zero gravity atmosphere, I had to think about which sports could be played in space, how spectators would watch those sports and how people would move between spaces," George said.

"I was able to explore new design ideas and stray away from the conventional stadium ideology to devise a design that allowed me to put my own spin and personality into an Olympic Moon Stadium."

George incorporated 'air shoes' to his imagined

environment, to enable visitors on the moon to float freely between games and gain panoramic views of the sports of their choice, like zero gravity swimming.

Jake Cumberland took a completely different approach, imagining the Moon as a Google-funded settlement, inhabited by social media celebrities who lived in roaming pods.

"My project was a poetic response towards the 'internet culture' of the 21st century," Jake said.

"Corporations like Google and social media companies hold a limitless amount of power over their users, and most people don't understand the implications of sharing their personal data with them.

"So, my design looks at social media as a catalyst for a 21st century dystopia, where I've created a portable Google data mine on the Moon.

"The purpose of the data mine is to collect data and assist in the development of a virtual world on the Moon, while YouTube influencers aboard data pods promote Google's new and advanced virtual world back to those living on earth."

Dr Sully said the anniversary of the Apollo 11 Moon landing provided an opportunity to reflect on such an extraordinary human achievement, and also to ponder what might have been.

"It seems particularly timely to consider these opportunities, given the resurgence of interest in space travel and space colonisation, whether it be in the form of lunar gateways or Mars colonies," Dr Sully said.

"The studio provided the opportunity to not only imagine how a space colony might look, but also offered the opportunity to reflect on the ethics surrounding some of the proposed activities, such as mining, manufacturing and tourism, as well as the role of new players (including the role of private and public interests in these ventures)."



Healthy Homes

Using home design to improve
your wellbeing





“I think people generally consider that architects incorporating health care into their design will result in a sterile or overly commercialised space, which we would say certainly isn’t correct.”

ANTHONY CLARKE

Many people underestimate the power our homes have to heal and contribute to our wellbeing.

University of Queensland Alumnus and architect Anthony Clarke practices empathic and experimental architecture. He believes a well-thought-out and researched design can provide significant benefits to clients living with chronic conditions.

“I think people generally consider that architects incorporating health care into their design will result in a sterile or overly commercialised space, which we would say certainly isn’t correct.”

“It’s very much a holistic approach; we try and understand as much as we can about their unique condition.”

Mr Clarke established his own practice, BLOXAS, in 2010. He takes a range of elements into consideration during his design process, including whether the client would require control over light and sound quality, or could benefit from sensory or therapy rooms.

“It started with a brief from a family who wanted to create a space suitable for their autistic son and since then we’ve been designing homes and other projects for people living with trauma, dementia and myalgic encephalomyelitis/chronic fatigue syndrome,” he said.

“Initially, we found people would refrain from sharing details about their health until it was too late. Now we are seeing that our clients are sharing openly because they’re starting to see that their information is part of a bigger picture in shaping healthy architecture.”

Mr Clarke joined fellow alumni in presenting at the UQ Art of Living Conference earlier in 2019.

Head of the School of Architecture Professor Cameron Bruhn said the conference examined the way we live and how we’re pushing the boundaries in residential architecture, creating homes that respond to people and place.



Fire-Safe Bamboo

This sustainable material could transform Australia's construction industry

A passion for sustainable construction led UQ PhD student Mateo Gutierrez to explore the potential of bamboo as an environmentally friendly local building material.

Bamboo is fast becoming a popular choice in Australia for flooring and furniture, but Mr Gutierrez said global construction industries could be transformed if building regulations incorporated bamboo as a structural building material option.

"Bamboo is an excellent building material because it is highly renewable and it has remarkable mechanical properties, it's lightweight, flexible and strong," Mr Gutierrez said.

"It's fast-growing as it is actually a grass, which increases the turnaround of harvests from timber's 30 years to three years for bamboo poles – there are many benefits."

After joining the University's fire safety engineering research group, UQ Fire, in 2016, Mr Gutierrez, a structural engineer by trade, began looking at the performance of bamboo structures when exposed to fire.

Global company MOSO International has provided the UQ Fire team with industry support, contributing engineered bamboo beams for laboratory-based fire testing.

"During testing, we found that when burning, bamboo creates a char layer that protects the inner layers that are not directly exposed to fire, which means it's relatively hard-wearing in a fire" he said.

"Like timber, bamboo suffers a reduction in structural integrity at high temperatures, but our goal is to understand how that reduction occurs and how we can predict the failure of load-bearing elements in a building.

"We aim to develop design frameworks that can predict how bamboo buildings will fare in fires, and these could be used to inform revisions of the Australian building regulations, and perhaps see bamboo in Australian urban environments."

Mr Gutierrez said bamboo still had some limitations as a structural material that needed to be worked through, like weak production chains, a lack of harvesting and engineering technology in the developing countries where it is mostly produced, as well as the misconception that bamboo isn't as strong or long-lasting as other materials.

In the face of climate catastrophe, Mr Gutierrez said bamboo offers the construction industry a sustainable solution with a far lower carbon footprint than other options.

"With research advancing in the area of bamboo fire safety, bamboo buildings in Brisbane are closer than we might think."



All Rhodes Lead to Oxford

**Brisbane-based process engineer
Nicholas Salmon is more than just a
high achiever.**

This UQ chemical engineering graduate won the University Medal in 2017 for his consistent academic excellence throughout his bachelor's and master's studies, but intellectual excellence is only one of the qualities that Cecil Rhodes set out in 1903 for his Rhodes Scholars.

Integrity of character, respect for fellow beings and a capacity for leadership were also must-haves for the postgraduate students that would be awarded the prestigious scholarships to study at Oxford University, and Nicholas embodies each of these.

Also a keen debater and musician, Queensland's newest Rhodes Scholar has long played an active role in the community, directing the skills he developed while

competing three times in the World Universities Debating Championships towards coaching the Queensland Schools Debating team to victory in 2016.

Now, Nicholas is turning his attention to a Doctor of Philosophy (DPhil) in Engineering Science at Oxford in 2020, where he will investigate the most effective ways to produce 'green' ammonia for fertiliser or energy.

He is currently employed as a process engineer in the Bauxite and Alumina Global Centre of Excellence of engineering, technical and professional services firm Worley.

"As an engineer, I contribute to my team by finding technical solutions that reduce our clients' water, energy and resource consumption in economically feasible ways," Nicholas said.

"The biggest threat to our community is climate change.

"It threatens our environment and economy, and in so doing threatens our very way of life.



Queensland Governor Paul de Jersey named UQ alumnus
Nicholas Salmon as the Queensland Rhodes Scholar at
Government House in Brisbane in October 2019.

"We need engineering solutions that allow us to continue to grow sustainably and prosper while reducing emissions and resolving economic concerns with transition to green energy.

"Oxford University is currently pursuing research in using renewable energy to generate green hydrogen and, subsequently, green ammonia using the Haber Bosch process," he said.

"I propose to investigate the geographical gap between renewable energy sources and downstream users of ammonia, a common fertiliser.

"Australia is rich in renewable energy, while other major energy consumers, such as India, Japan, and Korea, have far less capacity to generate plentiful renewable energy.

"My research would identify the most effective ways to bring together disparate renewable energy sources to produce green ammonia for use in fertiliser or as an energy source."

*"My research would identify
the most effective ways to bring
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energy sources to produce green
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as an energy source."*

NICHOLAS SALMON



Building Awareness

"... the client will take you on an ongoing journey once there is a relationship of trust, and will ask you to assist with other problems that they're experiencing."

PROFESSOR PAUL MEMMOTT

Image: Michael Marzik

Australia's architectural landscape has been missing a socially critical layer: the acknowledgement of a history of Indigenous architecture and landscape cultural histories. This recognition is vital to the cultural needs of Australia's Indigenous people.

Across the country, housing and community institutions like hospitals, clinics and courthouses have been designed to cater for the functional and aesthetic needs of Anglo-Celtic Australians, but fail to meet the cultural needs of Aboriginal and Torres Strait Islander communities.

Change has been decades in the making, with UQ researchers leading the way. In 1976, UQ established the Aboriginal Data Archive to focus on cultural safety in built environments – the first time research about Aboriginal architecture had been carried out in Australia.

Since then, the unit has grown to become the Aboriginal Environments Research Centre (AERC) – a research and teaching centre based in UQ's School of Architecture that focuses on increasing awareness of culturally appropriate architecture for Australia's Indigenous peoples.

Over the past 40 years, AERC researchers have worked tirelessly to change the way the architecture profession and government agencies think about culturally appropriate design, which has led to positive changes that are improving the lives of many Indigenous Australian communities.

Professor Paul Memmott has dedicated the majority of his career to this research, and it was his book *Gunyah, Goondie and Wurley: The Aboriginal Architecture of Australia*, in 2007, that first brought the term 'Aboriginal Architecture' to the profession's attention.

Professor Memmott says there needs to be an acknowledgement of catering to different cultures through architecture.

"If we look at traditional Indigenous communities, we start to see there are different behavioural styles when it comes to cooking, sleeping, preparing food, washing and socialising," he says.

"When we look at how people do those things, they can be done in characteristically different ways which can depend on how many people there are, the size of the household, how people divide into sleeping spaces, or what roles people have in the household.

"We also have to remember that all over Australia, Aboriginal cultures vary from region to region, so what might suit somebody in Inala or West End might be quite different to what would suit somebody in Alice Springs.

"It's important to develop a built environment that caters to those cultural differences. They're really basic things and it might be equally as different for a Vietnamese family or an Indian family."

Professor Memmott says the profession's growing understanding of the term is significantly contributing to Indigenous communities attaining their rightful place in the architectural and social history of the nation.

Influencing Policy

UQ's research into how Indigenous people use and procure housing, and the administrative barriers they experience, has also had significant influence on policy development and change.

For example, Queensland Government departments have relied heavily on AERC research to provide context and information about how to better provide services to solve Indigenous overcrowding and homelessness.

Professor Memmott says this is just one of the many ways AERC researchers are working with Indigenous communities to contribute to positive change by redressing problems that have plagued their communities.

"We have longstanding Aboriginal community clients who are collaborators with our research group" Professor Memmott explains.

"You'll start on a design issue and then a client group will take you on an ongoing journey once there is a relationship of trust, and will ask you to assist with other problems that they're experiencing. This is how we get involved in helping them to address issues like homelessness, crowding, family violence and social issues."

Research into community consultation and healthcare settings by one of the AERC's Adjunct Associate Professors Shaneen Fantin recently resulted in the development of a culturally sensitive health facility (pictured right) for Indigenous people in Cairns with an acquired brain injury, known as the Synapse Warner Street accommodation for people with complex disability – an Australian first.

Design practices People-Oriented Design (POD) and Indij Design, both directed by graduates of UQ's School of Architecture, took a collaborative and intercultural approach to this project, working between the client, design team and traditional owners.

Based on this community consultation, the facility's design included floor plans that suit Indigenous cultural norms of family visitation, taking into consideration room shape and scheme layout. The building's design also featured seasonal native planting to stimulate residents' senses, and had views to significant local story places.

More work to be done

While the AERC has made great progress over the past 40 years in raising awareness of the importance of culture in the built environment, Professor Memmott says there is "still a long way to go".

"The housing situation for Aboriginal people across many parts of Australia is still atrocious, and there is still extreme crowding, which exacerbates social and health problems"

"There's a lot more work to be done, views to be changed, and knowledge to be put into the public arena."

Learn more about the Aboriginal Environments Research Centre and how the team is working to advance research on Indigenous cultures and environments: bit.ly/2019-AERC

A Robot Called Pink

What it took to wake up a sleeping language

This story was adapted from an article published on The Conversation. By Dr Marie Bodén, School of Information Technology and Electrical Engineering, UQ with Dr Christine Chalmers, Associate Professor Therese Keane and Monica Williams.

A cute human-like robot taught students in a small, rural school how to code while also motivating them learn their local Aboriginal language.

The Maitland Lutheran School in South Australia, located on the traditional lands of the Narungga people, has around 240 students from Kindergarten to Year 9, and 16 per cent of them are Aboriginal or Torres Strait Islander.

The school wanted to support its Aboriginal and non-Aboriginal students and staff to connect with the heritage of the Narungga people, in partnership with the local Aboriginal community.

Past research has shown digital technologies with culturally responsive ways of teaching have helped to improve engagement and learning among Indigenous students in STEM subjects.

So, the school's principal decided to employ a small robot named Pink to engage students in understanding their local culture and language. And it worked.

By learning to program a humanoid robot, students engaged with an Indigenous culture and language and strengthened the connection between school, home and Country.

Why did Pink work so well?

Humanoid robots look like humans and have movements that are human-like, so students are drawn to them and want to make them function like a human, by making them talk, move their arms and walk. Some research has shown school students feel more comfortable – less anxious and self-conscious – learning a new language when they can practise on a robot compared to a human.

Apart from the cuteness factor, students believe the robot is not judgmental when they make mistakes.

How it panned out

It didn't take long for Pink to captivate the students, as the children began forming relationships with the robot and becoming attached to it. One of the teachers said her students treated the robot like it was a younger child.

Another teacher said the students humanised the robot within seconds, touching Pink's hand to shake it, talking to it and waving goodbye.

As the students' enthusiasm and confidence using the robot increased, they wanted Pink to have more functionality, so they started learning how to program her.

They wanted Pink to speak Narungga, but they discovered she could not pronounce the Narungga words when they typed them correctly into the programming language. So, using their problem-solving skills, students trialled the phonetic spelling of the words until they achieved the correct Narungga pronunciation.

The excitement of Pink and her learning spread across the school community, as students and teachers began greeting each other with "Hello" in Narungga. It was clear that a strong sense of pride in the traditional culture of the area was developing.

The principal said it hadn't just been fantastic for the school's Narungga students, it had been valuable across the board with all students.

"It's been a great way of getting them to network together ... to work on something that has an Indigenous perspective but means a lot to everybody," he said.

Emerging technologies can play a role in engaging the young with the languages and cultures of Australia's First Peoples.

The educators in this school recognised the importance of coding and robotics for their students' future and the far-reaching opportunities to integrate this technology in ways that build respect and understanding between cultures.

This project was part of a larger three-year study investigating the impact of humanoid robots on young children's learning and engagement.



“Everybody loves Pink when we bring her into schools. I believe it’s the cute human-like features that makes children want to be her best friend.”

DR MARIE BODÉN



“A circular economy is about keeping resources in circulation. It means we must recognise the nutritional, energy, and material value of food waste streams throughout the food supply chain.”

DR PAUL LUCKMAN





Fight Food Waste

Forty per cent of the food produced in Australia goes to waste, costing a total of \$20 billion each year.

Not only is food waste a loss to the economy, it's also damaging our environment. The breakdown of food waste in landfills emits millions of tonnes of greenhouse gases each year.

UQ chemical engineering researcher Dr Paul Luckman says there's more we could be doing with our organic and food waste. He's leading a new national program, called TRANSFORM, as part of the recently established Fight Food Waste Cooperative Research Centre (CRC), which will identify valuable products from waste streams, then develop processes and technology that can cost-effectively transform the waste materials.

"This program will also be looking to find the technology gaps and process limitations in transforming that waste," said Dr Luckman.

The team will work across 13 waste-transforming projects with experienced researchers, including UQ waste conversion expert Associate Professor Bronwyn Laycock, to deliver a tool kit for waste transformation processes.

"We're already looking at a wide range of projects, from turning food waste into supplements to fuelling sustainable wastewater treatment with food waste," said Dr Luckman.

"We're hoping to save 87 gigalitres of water through recovery and reuse, reduce 30 million tonnes in food waste and save at least 44 million tonnes of greenhouse gases emitted over 10 years."

The TRANSFORM program aims to create 5200 jobs in rural areas and save \$600 million in waste produce and waste-handling costs.

"It's not only generating growth, but it contributes to the idea of a circular economy."



How engineers are fighting food waste

The Fight Food Waste CRC has many industry and academic partners participating in food waste transformation projects, here are two of the projects.

Potatoes to products

Australia is the largest producer of potatoes in the southern hemisphere, yet up to 40 per cent of this produce is rejected because it does not meet market specifications. The large volume of waste is currently used for animal feed, where it sells for just \$10/tonne or it is disposed in landfill at a loss to farmers.

This project will explore options for the transformation of these waste potatoes into higher value products, including into functional foods, bioplastics, edible films, packaging materials, coatings and adhesives.

Researchers also aim to produce raw starch in Australia, reducing the 20,000 tonnes per year that we import due to the absence of a potato starch industry, and they see potato-based prebiotics as a high-end application for this starch. Research has shown that the less digestible starches like potato starch make superior prebiotics that can help prevent pathogen infections and the development of colon cancer, presenting a premium opportunity to commercial operators in this space.

Red meat processing

This project is aimed at increasing the circularity and sustainability of red meat processing, overcoming the challenges associated with animal protein production like biosafety and biosecurity. Researchers will work with commercial partner Australian Country Choice, a major red meat supplier to Woolworths, to identify practices that can best utilise waste produced across the red meat supply chain. The team will then explore solutions that could be adapted across the industry.



7 Reasons

to embrace electric vehicles

This story was adapted from an article published on The Conversation.

By Dr Jake Whitehead, Tritium E-Mobility Research Fellow, UQ Dow Centre for Sustainable Engineering Innovation

Despite the overwhelming evidence that electric vehicle technology can deliver significant economic, environmental and health benefits, misinformation continues to muddy the public debate in Australia.



Let's look at the facts –

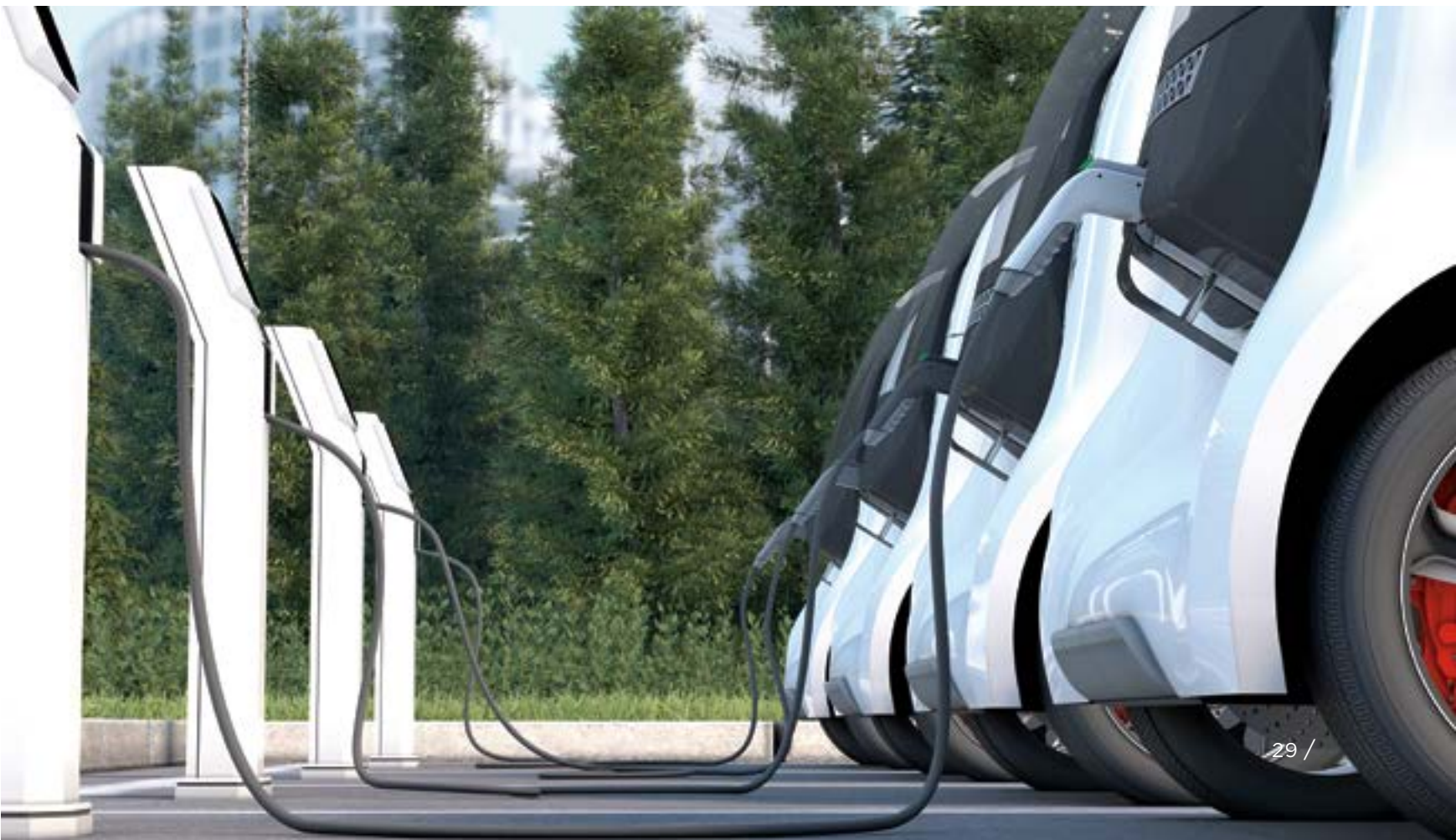
- 1) **Lower emissions:** Battery electric vehicles have no exhaust emissions. Their emissions are primarily determined by the upstream emissions: that is, from the production and distribution of the energy used to charge them. Electric vehicles in Australia typically generate about 40 per cent fewer emissions than a petrol vehicle.
- 2) **Lower across Australia:** Electric vehicle emissions vary depending on how dirty the region's electricity is. Victoria has the most emissions-intensive grid in Australia due to its reliance on brown coal and even in that state, the real-world fuel life-cycle emissions of a typical electric vehicle would still be 20 per cent lower than a typical petrol vehicle. In Tasmania, which is dominated by renewable energy, electric vehicle emissions would be 88 per cent lower than a comparable petrol vehicle.
- 3) **Cost savings:** Electric vehicles are 70–90 per cent cheaper to operate, potentially saving households more than \$2000 per year.
- 4) **Economic opportunities:** The Australian resources sector is well placed to capitalise on demand for minerals in batteries, such as lithium, and support the deployment of this technology globally using cheap, reliable and locally produced energy.
- 5) **Fuel security:** Australia is heavily dependent on imported fuels and holds reserves far below the International Energy Agency's obligated 90-day supply. So the more quickly we transition to electric vehicles, the more secure our transport system will be.

- 6) **Grid support:** Electric vehicles hold enormous potential to support our electricity grid. If Australia's 14 million-odd cars were electric, the energy stored in their batteries could power the entire nation for at least 24 hours, while still meeting average driving needs.
- 7) **Health benefits:** Noxious emissions from traditional vehicles take a massive toll on our health by contributing to rates of asthma and other chronic illnesses. Vehicle pollution causes an estimated 40–60 per cent more premature deaths than road accident fatalities in Australia. Electric vehicles provide a pathway to avoid these deaths.

Taking the Lead

Dr Jake Whitehead became UQ's first dedicated e-mobility researcher in 2019, thanks to a generous \$1.5 million donation to UQ through the Trevor and Judith St Baker Family Foundation.

The new research position – the Tritium Fellow in E-Mobility – was established in the UQ Dow Centre for Sustainable Engineering Innovation, and aims to make a significant contribution to the sustainability of the transport sector, which is one of the main generators of air pollution and greenhouse gas emissions around the world.



Sustainable Metals

Melting and recovering metals from scrapped electronic devices is just one of the solutions for the sustainable supply of critical materials being investigated by UQ researchers.

UQ's Pyrometallurgy Innovation Centre (PYROSEARCH) Director, Professor Eugene Jak, said the metals were needed for a new generation of electrical devices, including solar panels, computers, smartphones, batteries and fuel cells for electric cars and more.

"Part of the answer to ensuring a consistent supply lies in our existing electronic and other obsolete devices and how we dispose of them when they reach the end of their life-cycle," Professor Jak said.

"A smartphone alone can hold up to 20 different metals, which could be re-used in other technologies.

"By melting down these devices in high temperature processes, the critical metals can be retrieved and separated back into their original forms to be used again."

Associate Director of PYROSEARCH Professor Peter Hayes said the team had been working with industry for over two decades helping to develop technologies for the circular economy.

"PYROSEARCH is becoming an internationally recognised centre of expertise in the high-temperature processing and refining of metals," said Professor Hayes, a

veteran pyrometallurgy researcher with around 50 years' experience in the field.

"We're working to establish advanced chemical databases, which will allow researchers to predict complex reactions, and refine high-temperature copper and lead processing technologies used to recycle these critical metals.

"This will ultimately lead to improvements in the production and recovery of key metal elements, enabling improvements in recycling and energy savings."

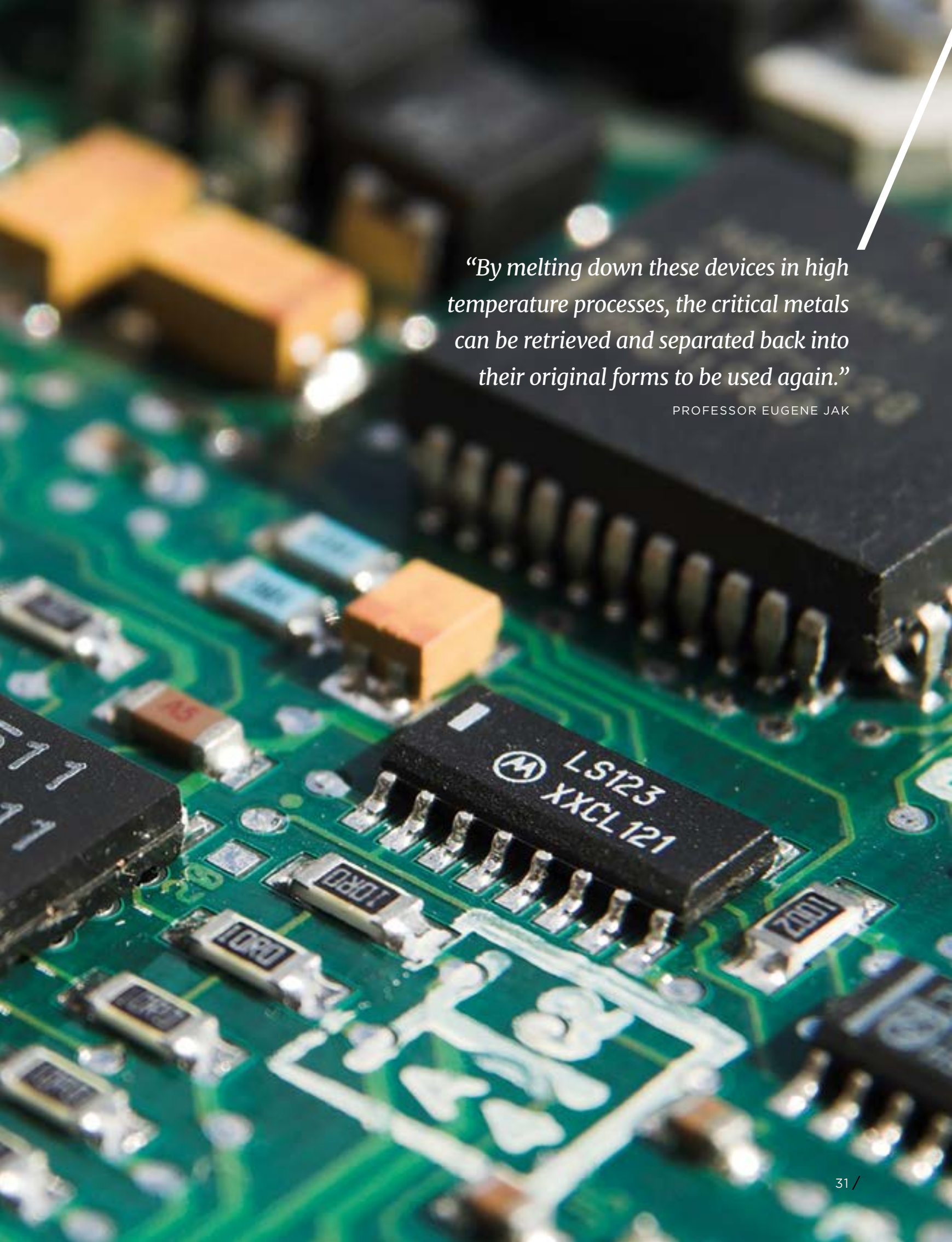
Professor Jak said the team was also focusing its attention on changing metals demand, such as copper, cobalt and nickel, which are essential for e-mobility, incorporating electric vehicles and batteries.

"Our research will enable industry to adapt to the changes in chemistry demands, modify existing and develop new technologies, increase efficiencies, improve recovery levels, reduce energy consumption and improve environmental impact," he said.

The projects are funded by a major Australian Research Council linkage grants and supported by a number of industry partners from around the world, including Umicore, a global materials technology and recycling group renowned for its sustainability practices.

UQ researchers recently met with leading metallurgical, recycling and advanced materials companies to discuss research collaborations.

"This is a new era for metallurgy; it's a very exciting time to be working in this field," said Professor Jak.



“By melting down these devices in high temperature processes, the critical metals can be retrieved and separated back into their original forms to be used again.”

PROFESSOR EUGENE JAK



Mining Knowledge

Minecraft embraces Australian minerals sector

Australian students will learn about our world-leading minerals industry and electric car manufacturing with a new 3D digital game for Minecraft's Education Edition, Mine Solar Car Lab.

In an Australian first, primary and secondary school students will use the world-famous Minecraft education platform to work together to collect raw materials, then use giant machines to build an electric car.

UQ mining engineering program leader, Associate Professor Mehmet Kizil said the game allows teachers and students to collaborate in the Mine Solar Car Lab virtual environment to learn about different minerals and metals sourced from Australian mines.

"By introducing students to a modern electric car in a collaborative, interactive way, Mine Solar Car Lab will excite children about the way electric cars are built and spark interest in learning more about this rapidly-changing industry," said Associate Professor Kizil.

"Determining strategies for managing resource scarcity and sustainability are key issues over the coming years and decades, and this perspective is an important one to introduce to students who might someday consider a career in engineering."

Minecraft is the best-selling video game of all time. Over 176 million copies have been sold across all platforms, and it has won numerous awards and accolades.

Since its release in 2011, it has amassed 91 million players worldwide.

This game demonstrates the minerals industry's innovative approach to educating young Australians on the exciting, technologically-driven Australian minerals sector.

In the game, students visit the fictional Institute for Voltaic Propulsion, a research facility full of researchers and enormous machines. They are tasked with mining and collecting raw materials used to build major parts of an electric car, then correctly inserting them into machines that will combine them into the finished components via an abstract version of a car factory.

Transformational educational tools like Mine Solar Car Lab will also provide Australian students with the opportunity to expand their computing skills, an increasingly important part of the world-leading modern Australian minerals sector.

This valuable new educational resource, which will be available on Windows 10, iOS and Android devices, was built and designed by University of Queensland researchers and funded by Mining Education Australia and the Minerals Council of Australia.

Cyber Security

How you can stay safe online

with Associate Professor John Williams, Deputy Director, UQ Cyber Security

In October 2019, the Australian Cyber Security Centre released statistics showing that over 13,500 reports of cyber crime had been received in the last four months, at an average rate of approximately one every 10 minutes. Identity theft, romance scams and ransomware are some of the most common complaints, but this is just the tip of the iceberg. The impacts of these crimes can be devastating for the victims, whether they are private individuals, businesses or organisations.



Four basic steps you can take to reduce the risks of cyber crime.

1 Enable two-factor authentication where possible

Passwords have been with us for a long time, but are vulnerable to being stolen, lost or intercepted. Two-factor authentication (also called 2FA, or MFA for multi-factor authentication) combines a password with a second way of proving your identity, often through a physical security token or smartphone app which generates a code that must be entered, in addition to your password.

Many online services now offer 2FA, including email providers, banking and online shopping sites.

2 Use secure, unique passwords

Many online services use your email address as your login identity. If you reuse your email password and that service is breached, attackers can use that to gain direct access to your email, and from there begin to take over other online services.

For this reason, you should always use a unique, strong password on important services such as email, online banking and social media, and never reuse these passwords.

Consider using a reputable password manager, which not only helps to remember all of your passwords, but can also generate secure, unique passwords for every different online account you use.

Finally, check to see if any of your online accounts have been compromised, by going to **haveibeenpwned.com**. This site gathers data about account breaches – already listing more than half a billion accounts – and makes it searchable, so you can see if you are at risk.

3 Enable automatic updates

Software companies like Apple, Microsoft and Google regularly publish software updates to fix security issues.

Installing these updates helps protect you against cyber criminals who exploit these issues to gain access to data and systems. In most cases you can configure your computer, phone or other device to automatically install security fixes.

4 Be sceptical

Scammers can try to trick you into visiting sites that look like the real thing, but are actually just copies designed to steal your login and identity information.

Never login to high value sites such as online banking or **my.gov.au** through links received in email or text messages. Go directly to the organisation's homepage and log in from there.

Finally, if you are in any doubt about the information contained in an email or text message, attempt to contact the business or person through an independent, verifiable means, such as their official website.

What should you do if you are a victim of cyber crime?

Cyber crimes against individuals, businesses and organisations should be reported through **cyber.gov.au/report**, but remember that if there is an immediate threat to life or risk of harm, call 000.

For more ideas on how to stay safe online, visit **cyber.gov.au/advice/EasyStepsGuide**



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Ice cold (sea)water, anyone?

Condensing an 80,000 word thesis down to a three-minute speech is not an easy thing to do, but chemical engineering PhD candidate Charmaine Lamiel does it with style.

After taking out first place in the School of Chemical Engineering Three Minute Thesis (3MT) competition, she backed it up with another win in the Faculty of Engineering, Architecture and Information Technology 3MT finals.

Ms Lamiel presented her innovative desalination concept in a quick 180 seconds at Customs House in Brisbane City for the UQ 3MT finals in September, taking the audience along for a scientific ride.

Asking the room why access to water during a drought is still a problem in a country like Australia despite being girt by oceans and seas, Ms Lamiel wondered aloud why we can't just use the seawater surrounding our island home to meet our needs when rains are scarce.

One of the main obstacles is the salt present in this water, of course.

"If you're thirsty, you might want to remove salt from the seawater before having a drink," she said.

"Easy – simply boil the water and collect the steam."

But the problem is that this process is energy-intensive and time-consuming, so to provide more drinking water the Australian government has built desalination plants to ensure there is enough water to go around in the future, when droughts are forecast to become more common.

"A Gold Coast desalination plant could fill an Olympic-sized swimming pool 50 times every day with the amount of seawater it turns into drinking water – the plants produce a lot of water," Ms Lamiel told the audience.

"Desalination works by forcing seawater in a 'yes or a no' membrane.

"Think about your coffee beans and your coffee filter. Yes – it allows caffeinated water to go through. But, no – it does not allow the beans to pass into your cup."

As membranes are at the heart of these desalination plants, the process becomes very expensive as 10 per cent of the annual cost to run the plant is used just to maintain the membranes, "and this cost is passed down to thirsty people like us".

"My study focuses on making membranes out of carbon materials because, unlike the commercial ones, carbon can withstand extreme and harsh conditions."

One of the most promising types of carbon for this project is graphene – the same material as the tip of a pencil (graphite) but divided a billion times.

"I put graphene in my membrane and the results? Yes to pure water, and definitely no to salt!"

The kicker? Using graphene in these membranes makes them highly conductive, a perk that the commercial products don't have.

This is a bonus as it means electricity can be sent rocketing through the membrane, blasting away accumulated salt that builds up and leaving the membrane as clean as new, reducing the need to replace it.

“A Gold Coast desalination plant could fill an Olympic-sized swimming pool 50 times every day with the amount of seawater it turns into drinking water.”

CHARMAINE LAMIEL

See Charmaine Lamiel's 3MT presentation on our YouTube channel:

bit.ly/2019-3MT



On Top of the World

Walking through a bamboo forest in the parks surrounding the National Museum of Korea, Anastasia Laczko could hardly feel further away from her sunny Queensland home.

The 8,000 kilometres between Seoul and the Gold Coast is vast, but Anastasia is not one to shy away from an adventure, and what an adventure she's having.

2019 has been an exciting year for this the fourth-year mechatronic engineering and information technology student, as she switched out a lecture theatre in Brisbane for the bustling streets of Bangalore in India while she completed a robotics internship with the Infosys Centre for Emerging Technology Solutions.

After two months in India and a quick hop, skip and jump over to Deajeon, Korea, she began her semester studying abroad at UQ's partner institute, the Korea Advanced Institute of Science and Technology, with the support of a New Colombo Plan Scholarship.

Before starting at UQ, Anastasia said she had never travelled outside Australia, but now she is drinking in the opportunities that the University has to offer.

Thanks to generous donors, countless hours applying for scholarships and an awful lot of hard work, Anastasia has built up a long list of accolades that have provided her with international travel opportunities, industry exposure and a more-than-full university experience.

"Receiving the New Colombo Plan Mobility Grant and UQ Idea Hub's support both had such a massive effect on my outlook," she said.

Anastasia spent one month studying with 19 other IT students from UQ at Dalian Neusoft University of Information, learning about Chinese startup culture and spending time exploring the city and culture; she spent a second month in Shanghai, working as an intern front-end developer at a crypto-currency analytics startup.

"Not only did these one-month travel experiences in Dalian and Shanghai, China give me a chance to explore new cultures and learn new skills, but they gave me a chance to understand my own heritage as a half-Chinese, half-Hungarian second-generation Australian.

"I have learnt first-hand how transformational it can be to view the world from a different cultural perspective."

Over the last summer holidays, Anastasia decided to keep honing her tech and innovation skills at home, gaining a Summer Research Scholarship so she could work with the UQ Co-Innovation Group.

Under the guidance of some of Australia's sharpest minds in the field, Anastasia designed and developed an assistive technology prototype. Her interactive photo album was designed to assist people living with dementia to prepare for visitors.

"My dream is to design and build social robots which improve the daily lives of others, so being able to combine my engineering and design skills in projects like this is very beneficial for me."

Anastasia took a left turn towards engineering in her final year of high school, when she learnt that she could combine her love of design and arts with her knack for maths and science, and she never looked back.

"The opportunities that scholarships have given me have completely transformed my university experience and enriched it with invaluable academic and cultural experiences, and I can't be thankful enough for the support donors have offered me."

"Knowing that someone else believes in my potential and has invested in my future has strengthened my dedication to my studies – I hope that one day I too will be in a position where I can support students to pursue their dreams."

Anastasia has also received a Johnian Residential Engineering Scholarship and an ICT Alumni Advantage Scholarship thanks to the generous donations of UQ alumni Peter and Margaret Hay and Bob Christiansen, and a Rio Tinto Excellence Women in Engineering Scholarship with thanks to UQ's ongoing industry partner Rio Tinto.

Show your support

If you would like to support driven and talented students like Anastasia in their pursuit to make the world a better place, please get in touch with the Engineering, Architecture and Information Technology Advancement Team at advancement@eait.uq.edu.au for more information.

Images (from top):

A building within the grounds of Jogyesa Temple, a Korean Buddhist temple. Seoul, South Korea

Archways of the Lotus Mahal. Hampi, India

A wild monkey at the Hanuman (Monkey) Temple. Hampi, India

Infosys interns in front of the Vittala Temple. Hampi, India

The colourful houses of Gamcheon Culture Village. Busan, South Korea



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Blooming

Undulate, E-Motion and Floral Symphony
delight visitors to UQ Bloom Festival

Students from UQ's Schools of Music, Architecture and Information Technology and Electrical Engineering came together to surprise and delight visitors to the 2019 UQ Bloom Festival in October with a series of interactive installations.

Visitors had the chance to walk amongst the installations and experience the bright coloured lights, music and soundscapes, and the beautiful and unique forms that the students had created.

The students drew inspiration from the natural environment, sustainability and the theme 'imagination', and Architecture Lecturer, Dr Fred Fiahlo Teixeira said the focus was around designing beyond boundaries.

Interaction design expert Associate Professor Stephen Viller said exhibiting the installations over

the week-long 2019 UQ Bloom Festival provided students with the opportunity to watch how their audiences interacted with their creations.

"The students were able to grow their understanding of how audiences expected to use the spaces and took the time to tailor the experiences throughout the week."

"For example, they watched people walk into the centre of E-Motion and twirl around, expecting the lights and sound to interact with them, so the project team re-coded their sensors and deployed another iteration the next day that provided the immediate immersive response people were looking for – and the audience loved it!"

Senior Lecturer in Music Technology Dr Eve Klein said by working together across the music, architecture and interaction design disciplines, and learning from academics outside their usual fields, students were able to craft installations much larger, more immersive and more ambitious than could be achieved working with one approach alone.

Image: Sarah Jeffrey

E-Motion

E-Motion harnessed data relating to how people arrive on campus (walking, cycling, public transport, private vehicles) as a basis for visual and sonic displays around a continuous screen wall. Sensor-based and physical interactions allowed audience members to explore different visual and sound experiences related to the transit data.



Floral Symphony

Floral Symphony featured a series of interactive blooms constructed through 3D printing with embedded speakers, lights and sensors. Audience members were able to generate visual and sonic performances through gestural interactions with the blooms.

Images: Laura Pham

Undulate

Undulate was centred around a rising and falling timber sculpture with embedded visual and audio elements. The installation followed social media posts related to the UQ Bloom Festival, driving the lights and sounds based on sentiment analysis of the posts.



Thank you to the students who contributed to these installations:

Benjamin Barruel, Alan Duong, Robert Evans, Dominika Geier, Jacob Hayden, Hoffmann Lai, Zhuoqian LI, Lu Lyu, Hanyue Wang, Timothy Sifontes-Holzberger, Daniel Yasar, Alex Miller, Aslam Marzook, Clay Carmichael-Griffiths, Digby Tilse, Laura Pham, Meg Takeda, Michael Mascadri, Damien Baptiste, Hamish Buchhorn, Jonathan Buttsworth, Wan-Ru Chao, Siyuan Chen, Giulia De Negri, Wooyoung Jo, Frank Hollingsworth, Paris Jacobs, Lei Jin, Yun Wa Lai, Seong Hyok Lee, Zhen Ling, Qiyao Liu, Thanh Mai Nguyen, Siubhan Rudge, Shiva Sarhangi Irdemoosa, Jing Wang, Zoe Weddell, Wenpeng Zhai, YuJing Zhang

The Unsolved Cipher

*This story was adapted from an article published on The Conversation.
By Dr Richard Bean, Centre for Energy Data Innovation, UQ*



This year I managed to decrypt a difficult cipher that, despite expert codebreakers' best efforts, had remained unsolved for 70 years.

The code was created by the late Cambridge professor and scientist Robert Henry Thouless, who passed away in 1984. He created it as a 'test of survival' to see if he could communicate with the living after his death. Thouless thought if he successfully transmitted cipher keywords to the living through spiritual mediums and the message was received, this would prove he had survived his death.

In 2019, I was more interested in seeing whether computer speed, storage and networking capabilities had advanced enough to break a code that had outlived its maker. After about five days I had my answer.

The cipher text read: INXPH CJKGM JIRPR FBCVY
WYWES NOECN SCVHE GYRJQ TEBJM TGXAT TWPNH
CNYBC FNXPFLFXRV QWQL

The solution: A number of successful experiments of this kind would give strong evidence for survival.

“In the present day, quantum computing threatens to make many current encryption algorithms obsolete.”

DR RICHARD BEAN



In the name of Psi-ence

In 1882, the Society for Psychical Research was founded in the UK. Its purpose was to study spiritualism, the paranormal, psychic powers and the possibility of life after death. During World War II, Thouless became one of its many famous presidents – a list that also included Britain’s future Prime Minister Arthur Balfour and radio pioneer Sir Oliver Lodge.

In the course of his academic work at Cambridge, Thouless devised experiments to test claimants for evidence of “psi” – a term he introduced in his 1942 paper ‘Experiments on Paranormal Guessing’. The word was used to describe all phenomena of ‘telepathy’, ‘clairvoyance’, ‘precognition’ or ‘extrasensory perception’ that could be tested or described.

He considered different ways to create an experiment which could test for survival after death. One test involved an object or message to be sealed in a package so after the author’s death mediums could attempt to describe what was inside. A disadvantage here was that the package could only be opened once to check an answer. So in his seminal paper ‘A Test of Survival’, Thouless turned to cryptography as a source of experiments.

He published two ciphers in this paper, which he called Passages. Passage II used a book cipher – a code in which the key comes from some aspect of a book or another text.

Cracking Passage II

In August 2019, I produced a table of English letter frequencies in a successful attempt to break an unsolved cipher of the Irish Republican Army, presented in a 2008 book co-authored by California computer scientist James J. Gillogly.

I used the books of Project Gutenberg – a large collection of books scanned or typed by volunteers – as the input texts. I wrote a program to check all 37,000 of the English books, using my table of letter frequencies to then score the output text for a solution to Passage II.

After a few days, I found the source book was ‘The Hound of Heaven’ by Francis Thompson, entered into Project Gutenberg in July 1998. This is a most appropriate text to reflect Thouless’s religious beliefs, as it is a famous Christian poem.

The lesson from this discovery is that book ciphers can still be a very secure way of encrypting text if the key text can be kept secret, as the only method of solution is to exhaustively test all texts. The most famous example of a book cipher is the Beale ciphers of 1885, which purport to describe the location of hidden treasure in the United States.

In the current age of Project Gutenberg and networked computer systems, Passage II could not have remained unsolved for long.

Due to the growth in computer speed, storage and networking capability, breaking Passage II became feasible. In the present day, quantum computing threatens to make many current encryption algorithms obsolete.

Any future similar tests of ‘survival’ will require the use of some kind of encryption algorithm that is immune to technological advances. As was the case with Thouless, whoever devises such a test will have to take into account that computer power in the future may make the science fiction of today a reality.

A person and a dog are silhouetted against a vibrant, starry night sky. The person is standing on a grassy hill, looking up at the stars. A dog is lying down on the grass next to them. The sky is a deep purple and blue, filled with countless stars and a bright, glowing nebula or galaxy in the upper left. The overall mood is serene and contemplative.

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