VOL. 9 | NO. 4 | MAY 2023

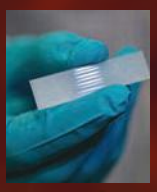
create

ENGINEERING IDEAS TO REALITY

ENGINEERS AUSTRALIA

CONFRONTING EXTREMES

ENGINEERS ON THE FRONTLINE OF NATURAL DISASTERS



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INTO ACTION

As the impact of fires, flood and other disasters grows, engineers are finding solutions to help communities respond and recover.

ENGINEERS AUSTRALIA

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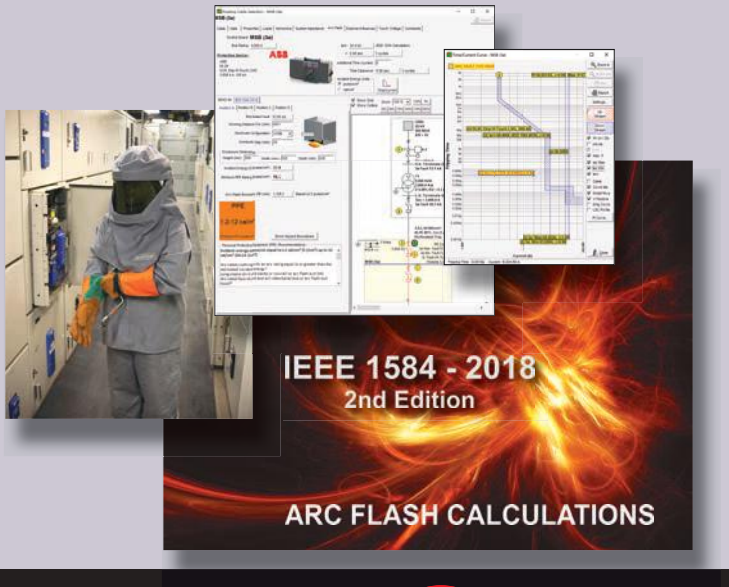

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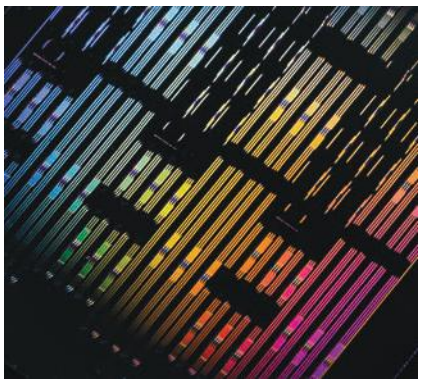

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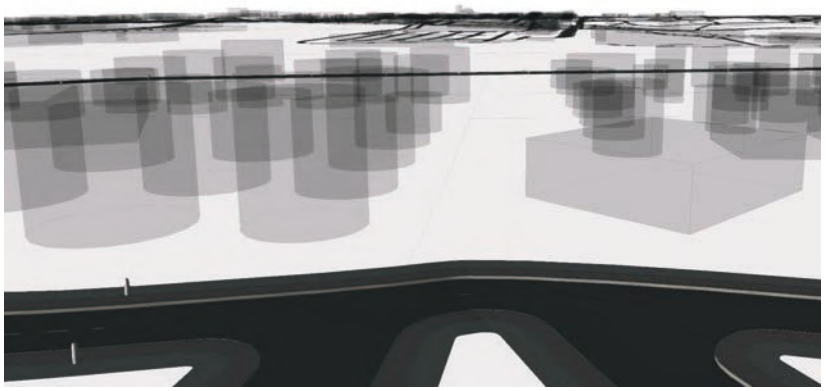

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Prepared for uncertainty

FROM MARKET ADJUSTMENTS TO DISRUPTIONS CAUSED BY CLIMATE CHANGE, ENGINEERS ARE WELL EQUIPPED TO HELP THE WORLD ADJUST TO THE FUTURE.

WELCOME TO the May edition of *create*. May is an industrious time of year when sectors from agriculture to manufacturing and construction are readying their assets and processes for the changing season.

With it comes a shift in integral elements of their business model: seasonal variation in supply chains, inclement weather plans to account for potential project delays, crop and irrigation rotations, winterising plants and equipment, and even the administrative frenzy that the looming end of financial year can bring.

These times of change can be a good opportunity to reflect on efficiencies, improvements and the cultural health of an organisation. With the pace of technological advance and changes in climate, global markets and social expectations of corporate conduct, it pays to cast a critical eye over existing structures in the engineering profession and ask if they still serve us well.

Is there a better way to achieve our goals? Are we still offering what our clients want? What is our competition doing? How can we open new opportunities?

If an organisation can identify ways to evolve, taking stock at a natural time of change can be a comfortable stepping-off point. Evidence-based and outcome-oriented strategic planning can bring short, mid and extended horizons into view.

Engineers have long held their ground as leaders for their ability to forecast the need for change, identify the drivers and manage the transition.

Nowhere is this more apparent than in combating climate change and the response to extreme events, whether that is at grassroots level helping communities recover from floods, fire and storms, or at a global scale supporting regions in crisis and transition.

In this issue, we take a look at the vital work of Engineers Without Borders (EWB) in flood-hit communities in northern New South Wales, as well as internationally.

Some of Australia's nearest neighbours — small island nations that are among the world's most disaster-prone — need a special level of support to keep their populations safe in the face of seasonal storm surges and rising sea levels.

EWB is helping deliver cyclone preparedness and storm-resilience.

While necessary focus is put on responding to the effects of climate change, engineers' advances continue to decrease our ecological footprint.

Exciting work is taking place in the food engineering space, where we see new sources of protein being identified to feed a growing population without adding to the carbon cost of existing livestock production methods.

May is also home to National Volunteers Week and we are pleased to have this opportunity to thank our volunteers for all they contribute to Engineers Australia.

Our organisation wouldn't be the robust, credible and influential body it is without the expertise and leadership our volunteers invest so generously in our chapters and colleges nationally and internationally.

On National Volunteers Week — and every week — we thank you for all that you do.

"Engineers have long held their ground as leaders in their field for their ability to forecast the need for change, identify the drivers and manage the transition."

Dr Nick Fleming
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Recognise a person or project for their conspicuous service to the engineering profession.

Those with examples of technical excellence or innovation in their work, or their team's project, can be nominated by their managers, team members and members of Engineers Australia's various engineering communities. Applicants can also nominate themselves.

Nominate now

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The engine of the profession

NATIONAL VOLUNTEERS WEEK IS CELEBRATED FROM 15 MAY IN AUSTRALIA EACH YEAR, AND THE CONTRIBUTIONS MADE BY ENGINEERS AUSTRALIA MEMBERS TO THE PROFESSION AND THE PUBLIC MAKE A REAL IMPACT.

"VOLUNTEERS AND office bearers are the 'engineers' in Engineers Australia," said Dr Nick Fleming of the more than 2500 members whose critical insights, effort and leadership help make the organisation's work so relevant and impactful.

"The voluntary contributions of our office bearers and members are inspiring, not just because of the valuable insights embedded in the work they do, but also because of the obvious commitment to advancing the Australian community that infuses their work."

ABOVE: Engineering Heritage Australia conserves historically important sites such as the WA Museum Boola Bardip.

These volunteers give their time and expertise to everything from developing the Australian Rainfall and Runoff guidelines and standards for the fire safety technical society to enhancing STEM engagement in schools.

Michael Taylor FIEAust CPEng (Ret), Chair of Engineering Heritage Australia (EHA), told *create* he was drawn to volunteering with EHA because his work saw him building on the work achievements of his predecessors.

"After 40-plus years as a member of Engineers Australia working in the Western Australian water industry, my best memories are of the engineering projects and people that have brought lasting benefits for the ommunity," he said.

"Wanting to know more about these existing works led to an interest in engineering heritage which supports the recognition and knowledge of our Australian engineering heritage and history."

Taylor's involvement with EHA has seen him complete a number of engineering heritage recognition nominations, contribute to the Engineers Australia's centenary books *Wonders Never Cease* and *Anything is Possible*, and chair the most recent Engineering Heritage Conference in Sydney this past October.

"There are many examples of national and state heritage-listed places whose conservation has only been possible with the skills and knowledge of heritage engineers," he said.

"It has been very interesting to learn about Western Australian examples such as the earthquake protection of St Georges Anglican Cathedral and the conservation techniques that were needed to incorporate several 100-year-old ▸

"WANTING TO KNOW MORE ABOUT THESE EXISTING WORKS LED TO AN INTEREST IN ENGINEERING HERITAGE WHICH SUPPORTS THE RECOGNITION AND KNOWLEDGE OF OUR AUSTRALIAN ENGINEERING HERITAGE AND HISTORY."

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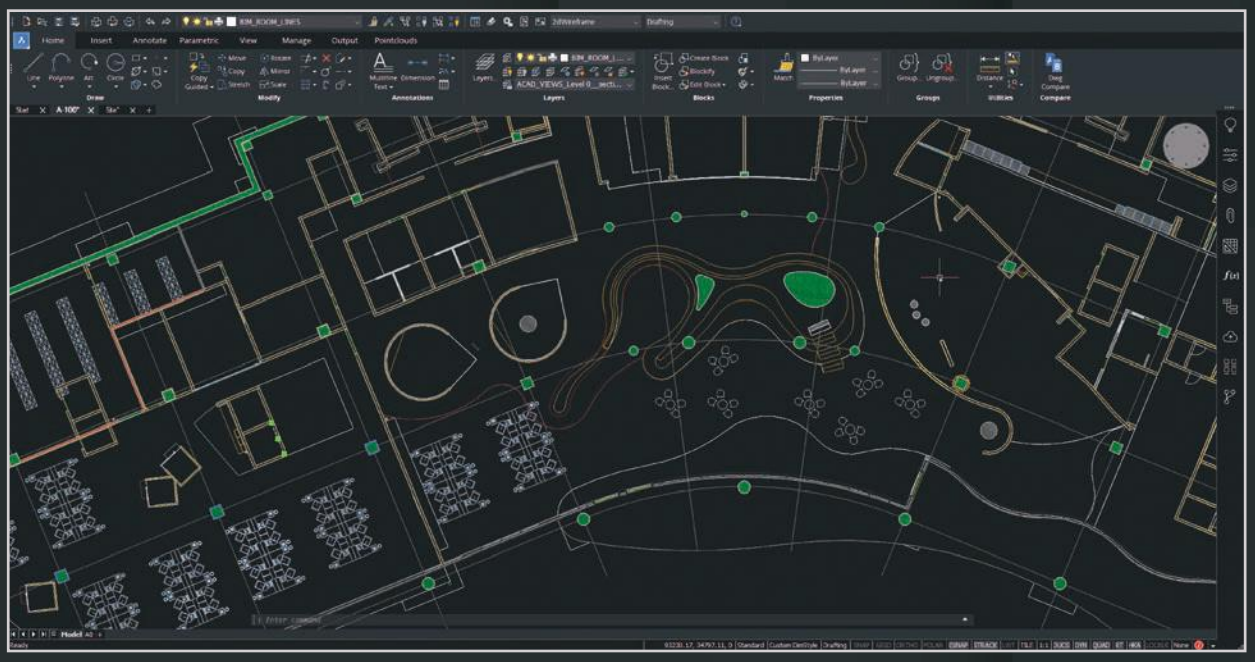

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buildings into the new WA Museum Boola Bardip."

Skye Blair FIEAust CPEng is Deputy President of the Engineers Australia Canberra Division Committee, which allows her to drive local action in her particular interest areas and engage with local members as well as government and other key stakeholders.

"It's super-rewarding seeing ideas come to life through Engineers Australia, and the impact it has on Engineers Australia members and our community," she said.

"My passion projects on the Canberra Division Committee are locally activating school STEM engagement and promoting the role of engineers in transitioning to net zero, whole-of-life carbon and a circular economy."

One example Blair gives is a STEM pilot program the division ran during February to celebrate Engineering Week.

"The pilot was born from wanting to design an impactful local school engagement event that could be sustained year on year within Engineers Australia's limited resources," she said.

"The event we designed paired local schools with local member organisations who showcased what engineers do and gave the students a chance to test it out. Over 150 students participated in the program, and 80 per cent of teachers said their students showed interest in pursuing a career in engineering after the event."

ABOVE (from top): Students participate in a STEM pilot program in Canberra; Michael Taylor; Skye Blair.

Volunteering, Blair said, has also helped broaden her professional network and enabled her to stay abreast of matters affecting the engineering profession.

"I would encourage all engineers to volunteer for an Engineers Australia community that best aligns with their area of expertise and passions," she said.

"It can be as simple as putting your hand up to volunteer at a local school, attending committee meetings to help shape [continuing professional development], or contributing to Engineers Australia's External Voice Project."

Taylor said that, as a retired engineer, contributing to engineering heritage efforts has been worth the effort as family and travel have come to replace his career as a priority.

"Being an Engineers Australia volunteer, you can make a difference," he said.

"You can contribute your experience but still learn from other volunteers."

Fleming said volunteers make our communities more vibrant, connected and tolerant.

"There are many reasons to volunteer, irrespective of age, engineering discipline or stage of career," he said.

"We see enormous untapped potential in our membership, which is motivating our work to implement more flexible, impactful and rewarding models for volunteering." ●

JONATHAN BRADLEY

"I WOULD ENCOURAGE ALL ENGINEERS TO VOLUNTEER FOR AN ENGINEERS AUSTRALIA COMMUNITY THAT BEST ALIGNS WITH THEIR AREA OF EXPERTISE AND PASSIONS."

IMAGE: COURTESY OF ST CLARE'S COLLEGE

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WORDS BY **SUSAN MULDOWNEY**

A GLOBAL CARBON DIET

REDUCING CARBON EMISSIONS WILL MEAN CHANGING THE FOOD WE EAT. LUCKILY, FOOD ENGINEERING IS COMING TO THE RESCUE.

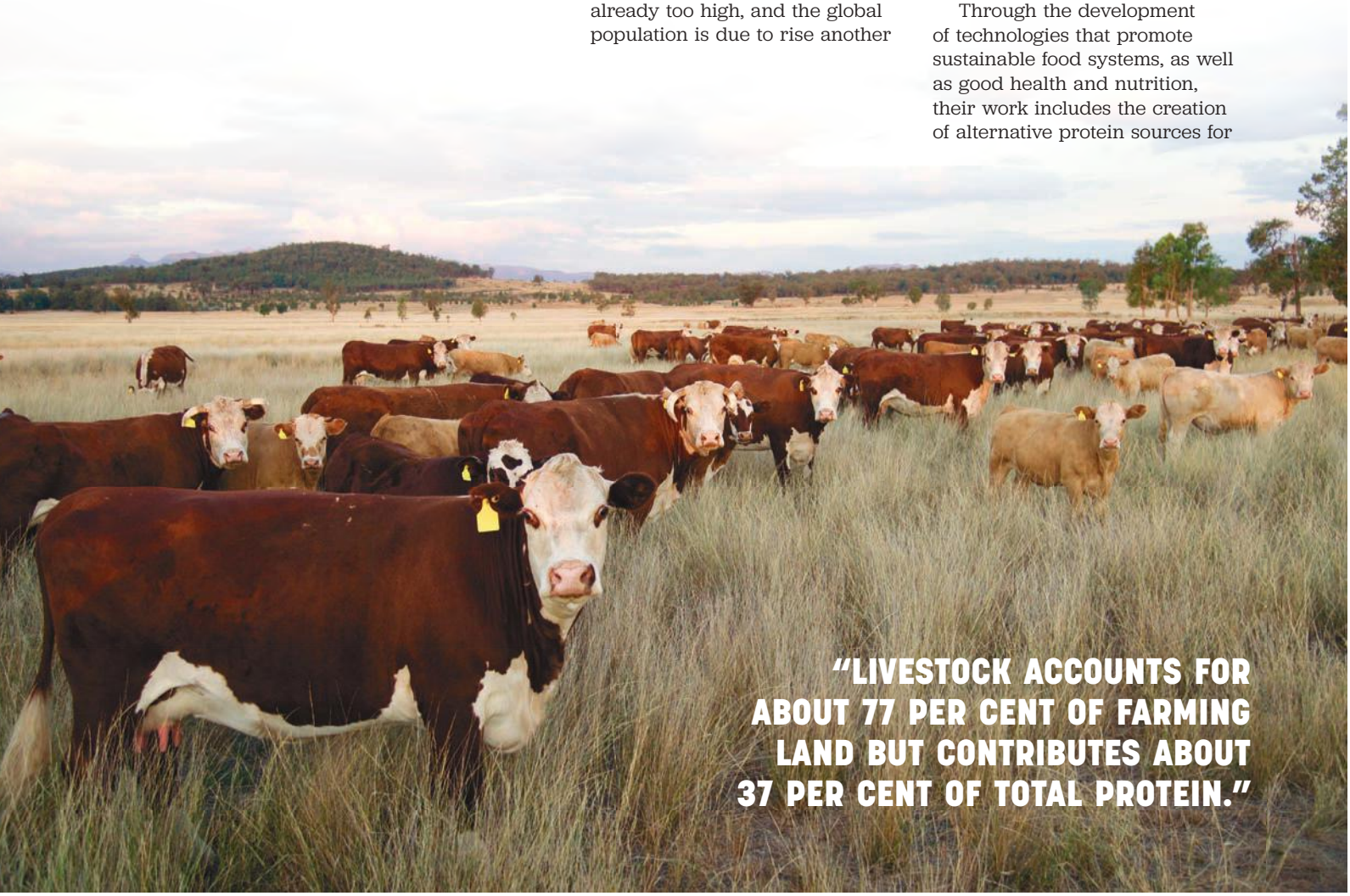
THERE'S NO getting around it: modern food production is responsible for more than a third of human-induced greenhouse gas emissions.

Animal-based foods account for about twice the emissions of plant-based ones.

In a world where emissions are already too high, and the global population is due to rise another 25 per cent to 10 billion by 2057, attention is shifting to how we can re-engineer the carbon footprint of our food.

This is one of the challenges that researchers at the University of Sydney's Centre for Advanced Food Engineering (CAFE) are working to answer.

Through the development of technologies that promote sustainable food systems, as well as good health and nutrition, their work includes the creation of alternative protein sources for



"LIVESTOCK ACCOUNTS FOR ABOUT 77 PER CENT OF FARMING LAND BUT CONTRIBUTES ABOUT 37 PER CENT OF TOTAL PROTEIN."

manufacturing innovative and nutritional food.

"We need to reduce our reliance on meat, but that requires creating foods that provide the same kind of satisfaction," said CAFE Director, chemical engineer Professor Fariba Dehghani, who leads a cross-disciplinary group of industry-focused researchers specialising in engineering, agriculture, nutrition, chemistry, molecular biology and medicine.

"Livestock accounts for about 77 per cent of farming land but contributes about 37 per cent of total protein," she said.

"Plants are a much higher source of protein, but a challenge is to make more of their proteins digestible. That is something that we are aiming to solve."

PROTEIN MINUS MEAT

Change in food production is under way across the globe. Bloomberg Intelligence estimates the plant-based protein market will be valued at more than US$162 billion by 2029, up from US$29.4 billion in 2020.

The development of alternative proteins is also attracting government attention in Australia, with the New South Wales Government's Tech Central Research and Innovation Infrastructure Fund granting $2.2 million to the University of Sydney's Alternative Protein Application Centre (APAC).

One of the key challenges in developing plant-based protein is ensuring that it delivers on taste as well as texture.

However, Dehghani, who is also the co-lead of APAC, said solving this challenge can come at a cost to nutritional value.

"Nutrition is often placed third in the list of priorities, after taste and texture," she said.

"Most of the alternative meat in the market also comes from soy, but it's not a major source of legume or pulse produced in Australia."

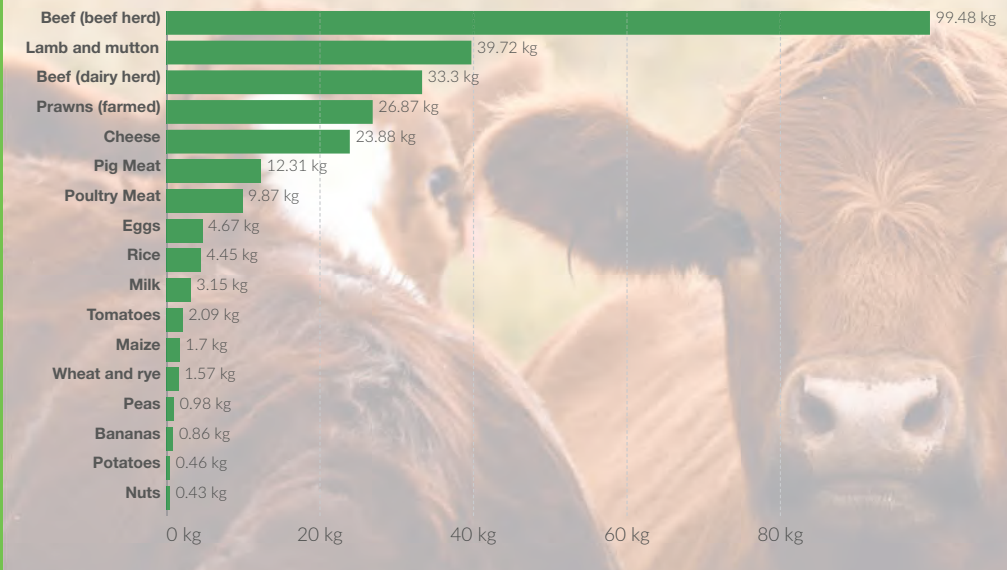
CAFE is currently working on a project to convert Australian-based pulses, such as peas, into protein-rich foods.

It's also seeking to make more plant proteins digestible through methods such as enzymatic hydrolysis, a chemical digestion process that breaks down complex molecules within food.

"We're also looking at other cost-effective methods like enzymatic fermentation to make plant-based proteins ▸

GREENHOUSE GAS EMISSIONS PER KILOGRAM OF FOOD PRODUCT

Emissions are measured in carbon dioxide-equivalents.[1] This means non-CO_2 gases are weighted by the amount of warming they cause over a 100-year timescale.



1. Carbon dioxide is the most important greenhouse gas, but not the only one. To capture all greenhouse gas emissions, researchers express them in "carbon dioxide-equivalents" (CO_2eq), weighting each by its global warming potential (GWP) value. GWP measures the amount of warming a gas creates compared to CO_2, with CO_2 given a value of one. This warming can also be stated over different timescales: to calculate CO_2eq over 100 years, we'd multiply each gas by its GWP over a 100-year timescale). Total greenhouse gas emissions — measured in CO_2eq — are then calculated by summing each gas's CO_2eq value.

Source: Joseph Poore and Thomas Nemecek (2018).

more digestible," said Dehghani. "Proteins are amazing molecules. The way that they combine to make strong textures and structures – it's like an art form. We need to bring engineers and scientists together to look at how we can fold the proteins together."

CULTIVATING THE FUTURE

One of the most innovative – and ambitious – alternatives to meat-based proteins involves "cellular agriculture", which produces animal proteins through processes such as microbial precision fermentation and the cultivation of animal cells in a lab.

Microbial precision fermentation uses synthetic biology techniques to engineer single-celled organisms that produce proteins that can be made into food products.

Dehghani describes the process as similar to brewing beer.

"Fermentation facilities already exist, but we'd need to change the production from beer to protein."

Cultured meat is another type of cellular agriculture that involves cultivating animal cells in a lab to replicate the sensory and nutritional profiles of conventional meat.

The process involves feeding cells with an oxygen-rich culture medium consisting of nutrients such as amino acids, glucose, vitamins and inorganic salts, supplemented with proteins and other growth factors.

"The cells from animals are very fragile compared with bacteria," said Dehghani. "They require a specific environment to grow, and you need to add some growth factors, antibiotics and other things to keep them alive.

"There are so many concerns about cultured meat that need to be overcome, such as how to get rid of the growth factor and how to make it more cost-effective compared with other sources of the protein."

ENGINEERING THE MENU

With the requirement for secure and sustainable sources of protein increasing, research is under way to develop protein alternatives from cultivated insect cells.

"The level of protein from insects is comparable with

"PROTEINS ARE AMAZING MOLECULES. THE WAY THAT THEY COMBINE TO MAKE STRONG TEXTURES AND STRUCTURES – IT'S LIKE AN ART FORM."

BELOW: Professor Fariba Dehghani, University of Sydney.

IMAGE: UNIVERSITY OF SYDNEY

that from beef livestock, but the fat level is much lower, so it's actually healthier," said Dehghani.

"The level of iron is also much higher. Of course, many people are sceptical about using insects as a source of protein, but there's a lot of research into using insect cells, rather than actual insects, to produce protein."

What's more, Dehghani added, the cultivation of insect cells may be easier than producing protein from other animal cells.

LEFT: Crickets can be powdered and used in food. ABOVE: The University of Sydney's Centre for Advanced Food Engineering.

"Unlike mammalian cells from livestock, insect cells don't need to be grown under a controlled condition of 37˚C, which makes it more cost-effective, and they don't need CO_2 to grow. They are also resilient to pH change, and they require less nutrients.

"Insect cells are already used for the production of vaccines worldwide, but they can certainly be used to produce protein and to mimic the fatty taste that many consumers enjoy from meat."

Engineers play a vital role in solving the challenges of sustainable protein sources and shaping the future of food, she said.

"THERE ARE LIMITATIONS TO THE USE OF LAND. WE NEED TO DEVELOP MORE ALTERNATIVE, NUTRITIOUS FORMS OF PROTEIN FOR THE FUTURE."

"The global population is growing, and the consumption of meat is actually growing even faster," Dehghani added.

"We need more water and soil to produce meat from beef, pork or poultry – and there are limitations to the use of land. We need to develop more alternative, nutritious forms of protein for the future. It's a growing area that requires the attention of more engineers." ●

Laboratory lunch

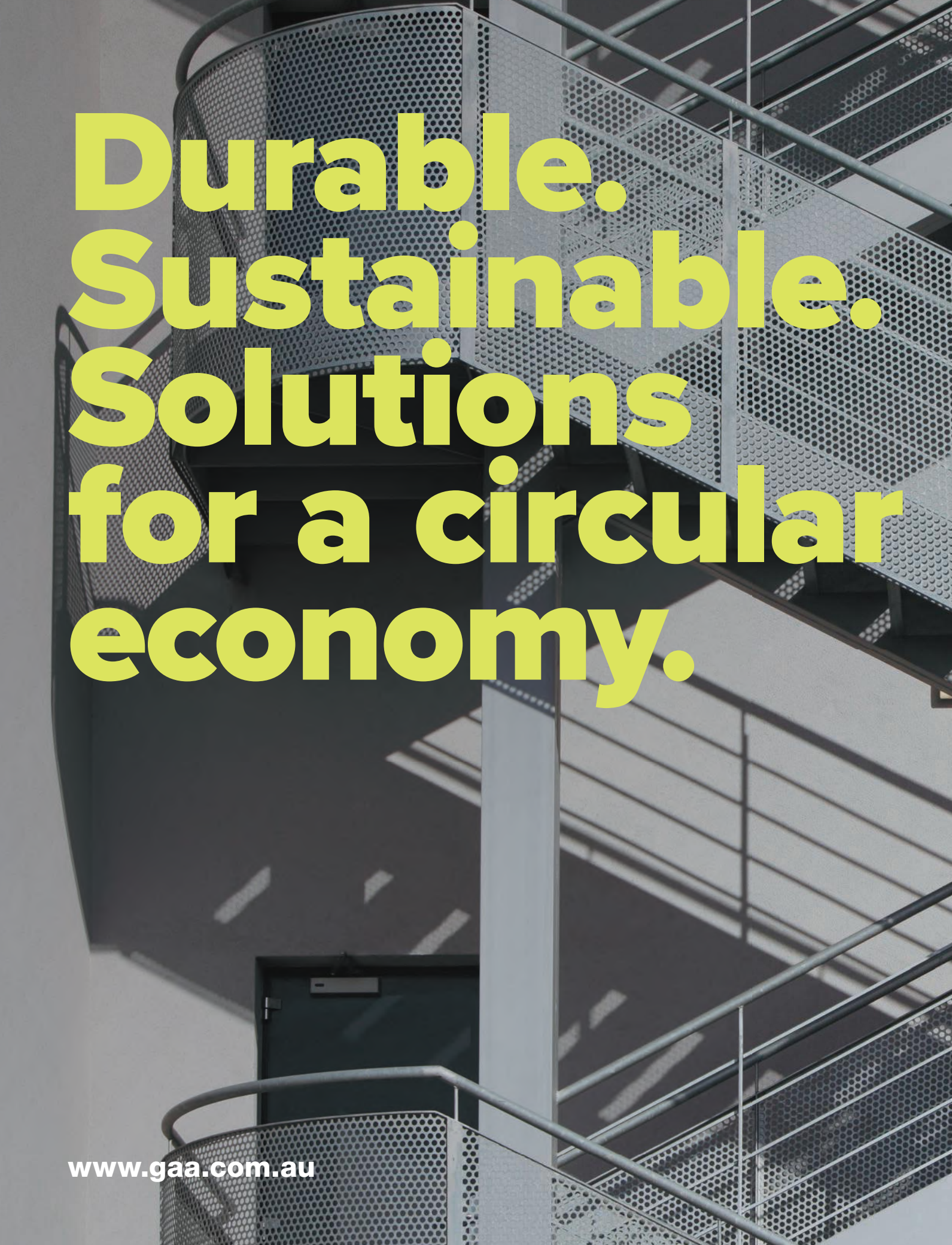
Centre for Advanced Food Engineering Director Fariba Dehghani described research into cultured meat as "very ambitious" but noted that a lot is being invested in this area.

"In Europe, companies like DSM and Nestle are exploring animal cell culturing and cultivation to produce protein," she said.

"They are considering things like 'texturisation' — mimicking the muscle tissue from animals. There are many aspects that they need to address, but the investment is huge."

Backing cultured meat is a priority in places like Singapore, which in 2020 became the first jurisdiction to approve the commercial sale of cultured meat.

The Singapore Government has invested US$104 million in its Food Story research and development program, which includes the development of new biotech-based foods.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WORDS BY **HELEN HAWKES**

CONFRONTING EXTREMES

THE WORLD IS FACING MORE EXTREME AND MORE FREQUENT NATURAL DISASTERS — AND ENGINEERS ARE AMONG THOSE ON THE FRONT LINES.

AS CLIMATE change sets in, instigating more frequent - and often, more extreme - natural disasters, engineers are increasingly at the vanguard of efforts to blunt the onslaught, and prepare communities to cope.

From flood predictions to fire behaviour research, it's their technical expertise that can make the difference between life and death for those caught up in nature's fury.

Disasters take lives and livelihoods, and a growing economic toll – $38 billion a year on average, a figure estimated to reach at least $73 billion per year by 2060, even with lower emissions, according to the National Emergency Management Agency (NEMA).

In the face of devastating fires and floods, the Australian Government set up the agency in September 2022 to better respond in times of disaster, and plan for long-term preparedness and faster recovery.

While NEMA funds programs and initiatives, and provides round-the-clock all-hazards monitoring and operational coordination, it is engineers – as creative problem-solvers and systems thinkers – who are among those at the forefront of the fight against climate change.

Since the devastating "once-in-1000 year" floods in the Northern Rivers region of New South Wales in March 2022, Engineers Without

Borders Australia (EWB) has engaged engineers, including individual professionals and employees of engineering firms Arup and Douglas Partners under pro bono programs, to assist residents with geotechnical assessments, advice on waterway crossings, and the structural assessment of buildings.

CEO Eleanor Loudon said EWB was approached by Lismore-based non-profit Holding Hands Underground for engineering support and more than 100 households registered for help.

"These have concerned everything from washed out creek beds and waterways to internal roads and multiple occupancy housing," she said.

"We have deployed civil, structural and environmental engineers, and are looking for funding to continue to assist people who are falling through the cracks."

With concerns in the region about rebuilding ahead of another possible flood, Loudon said advice on retaining walls or raising houses has been in demand.

Engineering volunteers conduct site visits, scope management plans and deliver options reports for each affected household.

This is essential in expediting the repair and restoration process, and to reduce the prolonged delays that communities are experiencing – improving the lives of residents, increasing economic stability and improving public safety, said Loudon.

Further afield, in Vanuatu, EWB engineers and Arup Australasia are implementing technical solutions and working on sector and systems-strengthening projects following cyclone activity.

Their Emergency Sanitation Guidelines, developed with Vanuatu's Ministry of Health, won an International Philanthropy Award; these focus on designing sanitation that withstands natural disasters but also on sustainable and long-term change in partnership with government and local non-government organisations.

ABOVE: Responding to flood damage to pipes in the Northern Rivers region of New South Wales;

ABOVE: Eleanor Loudon, Engineers Without Borders. LEFT: A bridge solution in the Solomon Islands.

"WE HAVE DEPLOYED CIVIL, STRUCTURAL AND ENVIRONMENTAL ENGINEERS, AND ARE LOOKING FOR FUNDING TO CONTINUE TO ASSIST PEOPLE WHO ARE FALLING THROUGH THE CRACKS."

IMAGE: ARUP

Loudon said one part of the project involved engineers developing composting toilets for higher-ground areas. They are now designing footbridges for areas that become inundated with water so children can get to school – "something UNICEF will look at scaling up if we get it right".

CYCLONES AND STORM SURGE

BRUCE HARPER CPEng FIEAust, director of Systems Engineering Australia and Adjunct Professor of Engineering at James Cook University, is a specialist civil engineer with more than 45 years of experience in coastal, ocean and wind engineering, including numerical and statistical modelling of extreme events.

"I'm an avid 'modeller' borne of the innovative James Cook University systems engineering initiatives of the 1970s," he said.

"I developed Australia's first storm surge model of tropical cyclones in the late '70s and one of the very first insurance loss models in the mid-1990s that adopted GIS and Monte Carlo techniques to consider the impacts of tropical cyclone winds and storm surge, later extending to severe thunderstorm downbursts, hail and tornado."

In 2005, Harper created the SEAtide prediction and analysis system, which enables tropical cyclone forecasters and emergency managers to rapidly evaluate the possible impact to coastal communities of storm tide and destructive wind threats.

"It provides an intuitive operating interface that is easy to learn and operationally efficient," he said.

"A central map display is supported by a data browser and a wide variety of space and time graphical output."

The SEAtide software was initially used by the Bureau of Meteorology before it developed its own Australia-wide system, ▸

and is still used by the Queensland Government.

It proved its accuracy during the Yasi Category 5 cyclone in 2011, which ploughed into the Cassowary Coast near Cardwell.

Harper's validated Australia-wide synthetic 50,000-year tropical cyclone wind climatology has also been widely applied in the design of buildings, towers, and wind or solar farms.

The guidelines he developed for the World Meteorological Organisation have assisted tropical cyclone forecasters and researchers globally to convert intensity estimates into a common framework.

Among the recommendations were that forecasters and researchers ensure that the siting, instrument selection, sampling, processing, documentation and archiving of wind data automatic weather station networks are carried out in a manner that will ensure accurate estimation of the mean wind and its associated turbulence properties.

As a minimum, this includes the 10-minute averaged wind (or V600) and the three-second peak gust in each 10 minutes (known as V3600) – preferably including the one-minute average wind (or V60), said Harper.

"Where possible, we recommended that episodes of high wind – say, greater than 17 m a second – should be recorded continuously at 10 Hz sampling to provide research-grade datasets."

The research has since been widely adopted and has contributed to more standardised reporting of tropical cyclone intensity.

"THE FORECASTS ARE GETTING MUCH BETTER AND, WITH MATURE STORMS, IT'S NOW RELATIVELY STRAIGHT FORWARD FOR THE BUREAU OF METEOROLOGY TO PREDICT WHERE THEY WILL GO."

ABOVE: Bruce Harper, Systems Engineering Australia. LEFT: Damage caused by Cyclone Yasi in Tully, Queensland.

Harper tells *create* that as early as the 1970s, after Cyclone Althea swept across Townsville, there was an epiphany among engineers who realised building standards and regulations were a cottage industry and mainly council specific.

"There was a groundswell, accelerated by Cyclone Tracy [which hit Darwin on Christmas Day 1974, killing 71 and devastating 80 per cent of the city], and the Australian Wind Loading Committee completely revised its standard, with Australian buildings required to be capable of surviving a 1000-year return period windspeed."

Even though that figure was later reduced to a 500-year return period, engineers see a lot of building damage that, according to the standards, shouldn't happen.

"There is not much point engineers saying we know what the extreme windspeed might be if it's not actually built to the standard," he said. "Ultimately, regulation and inspection are at the heart of it. This is a major problem for community resilience going forward."

Are we prepared for the next cyclone?

"It depends where it hits," Harper said.

"The good news is that, with the increasing availability of satellite sensors and models, the forecasts are getting much better and, with mature storms, like Debbie, which characteristically emanate from far offshore, it's now relatively straight forward for the Bureau of Meteorology to predict where they will go."

However, the nationwide focus of climate disaster funding on recovery rather than avoidance is one that needs to change, Harper believes.

"The real crisis in this country is where the lack of historical foresight in flood planning is going to keep hurting us until real action is taken," he said.

WATER INUNDATION

IT'S BEEN one year since the 2022 eastern Australia floods, which were estimated to be, at $9.6 billion, the costliest in the country's history.

Environmental engineer Juliette Murphy CPEng, CEO and co-founder of FloodMapp, which provides real time flood intelligence for emergency managers, said a Productivity Commission inquiry into natural disaster funding found 97 per cent of that money went towards reconstruction and recovery, compared to only three per cent for mitigation and community resilience measures such as flood intelligence and early warning systems.

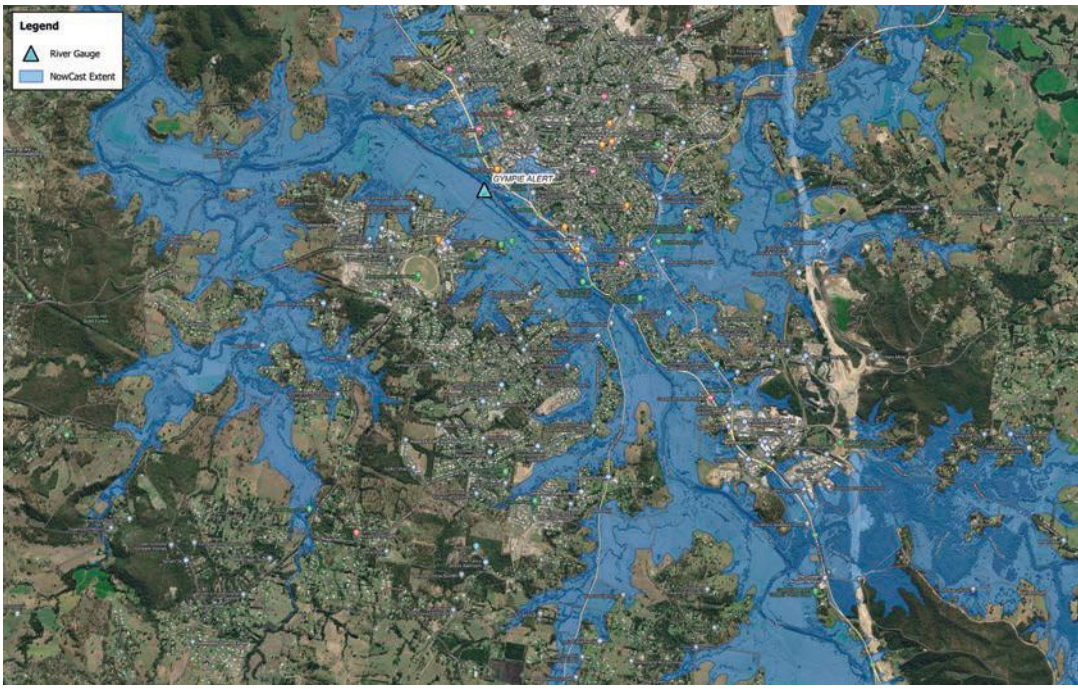
With increasingly severe flood events, Murphy believes we need more wide-scale investment – not just in the recovery stage of flood response, but early warning tools.

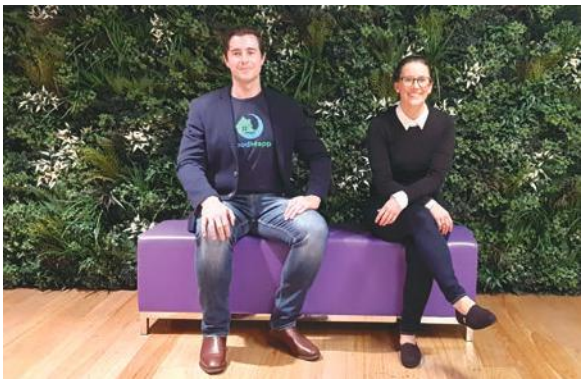
"While Lismore had some excellent flood risk studies and floodplain management planning done by local government and engineering consultants, these rely on a limited number of static flood risk scenarios based on climate and flood data we have observed historically," she said.

"Climate change means that we are now seeing more frequent and more severe flood events, and we need to be able to expect the unexpected.

"Operational flood intelligence and early warning systems are crucial to support emergency managers in operationalising their flood risk management plans, particularly where events exceed all historical floods or modelled risk scenarios."

On a mission to reduce the impact of flooding and save lives, Murphy and her co-founder Ryan Prosser have developed mitigation solutions in FloodMapp – technology that provides scalable, real-time flood intelligence.





"THE REAL CRISIS IN THIS COUNTRY IS WHERE THE LACK OF HISTORICAL FORESIGHT IN FLOOD PLANNING IS GOING TO KEEP HURTING US UNTIL REAL ACTION IS TAKEN."

ABOVE (from top): FloodMapp provides real-time flood intelligence; company founders Ryan Prosser and Juliette Murphy.

FloodMapp's Dynamic Automated Scalable Hydroinformatics – or DASH – uses forecast and observed rainfall, river height and catchment characteristics to produce ForeCast, NowCast and PostCast.

The novel hydrology and hydraulic modelling technology was specifically developed for emergency management and combines traditional engineering principles with advances in automation and machine learning.

"FloodMapp delivers operational intelligence that supports emergency managers with a common operating picture, and situational awareness on asset-level flood impact to inform decision making and targeted response," Murphy said.

To prove this, FloodMapp first worked with Queensland Fire and Emergency Services (QFES) in the State Disaster Coordination Centre (SDCC) during a March 2021 flood in the Logan Albert Catchment.

It not only accurately predicted the river peak, at an upper limit of 12.5 m, but produced a detailed inundation map of the impact.

"The forecast model was delivered digitally as a live mapping feed and ingested into the QFES Esri ArcGIS portal as a digital map," Murphy said.

Data interoperability meant that the SDCC was able to overlay the map with its internal population and asset datasets to provide situational awareness of the potential flood impact to people, property and critical infrastructure – and plan for ▶

evacuation 24 hours before the flood occurred.

"It also facilitated a common operating picture with other disaster management agencies," said Murphy.

"With this speed and level of accuracy, deployed as a shared situational awareness, QFES and the Queensland Police Service were able to rapidly pinpoint impacted properties and plan highly targeted, safe and timely evacuations and community messaging."

FloodMapp technology is now used by such companies as Energy Queensland, Transport for NSW and Origin Energy.

But its largest government investment has come from the US Federal Emergency Management Agency, which will use Australian engineers to provide operational flood inundation and analytics data feeds, including assessment of potential damage to property.

"CLIMATE CHANGE MEANS THAT WE ARE NOW SEEING MORE FREQUENT AND MORE SEVERE FLOOD EVENTS, AND WE NEED TO BE ABLE TO EXPECT THE UNEXPECTED."

BUSHFIRE BEHAVIOUR AND PREPAREDNESS

THE WORLD has witnessed an unprecedented scale and frequency of wildfires in the 2020s, especially in eastern Australia and the western United States.

In the latter, there were eight fires in 2020 alone, affecting 5.3 million ha from Alaska to New Mexico and costing US$3.3 billion.

Despite arduous efforts to improve our understanding of these catastrophic events, we are still far from unlocking the mysteries of their behaviour and their impact on ecosystems, communities and infrastructure, said Dr Alexander Filkov, a Senior Research Fellow at the University of Melbourne, who is determined to create a new paradigm for bushfire science and engineering.

A mechanical engineer and combustion scientist, his research focuses on better understanding dynamic fire behaviours, their influence on ignition and combustion of fuels, transition mechanisms of wildland fires into wildland-urban interface areas, and fire performance of structural materials.

As the co-leader of the Ignition Resistant Communities subgroup of the International Association for Fire Safety Science, and a board member of the International Fire Safety Consortium, Filkov collaborates with global experts to advance knowledge of large wildfires and their interactions with the built environment.

A current research project, in conjunction with UNSW, Victoria University, CSIRO's Data61 and San José State University, focuses on understanding how fire lines merge together – a phenomenon that has critical implications for predicting the behaviour and spread of large bushfires.

BELOW: Dr Alexander Filkov, University of Melbourne.

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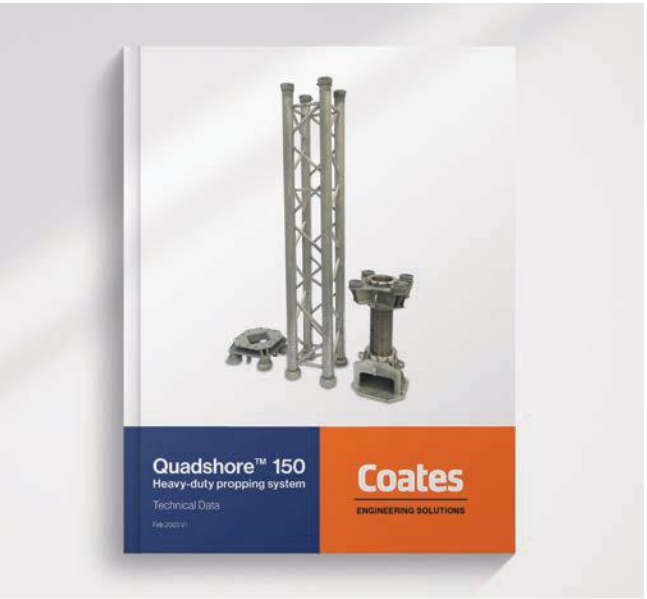
4. Reduced costs for labour, transport and consumables

Compared with a conventional propping system, Coates estimates that Quadshore 150 will reduce transport costs due to its lighter weight and higher capacity, which means less equipment, machinery and labour are required on site. The boltless design will also result in significant cost savings on consumables throughout the entire lifecycle of the product.

5. Lower carbon footprint due to less transport

Quadshore 150 is more environmentally sustainable than conventional propping systems in a number of ways. As it is made with higher-grade steel, there is less material used in its manufacture and less energy is required for its transportation. Boltless connections mean less waste of any kind of steel componentry.



Learn more

To request a copy of the Quadshore 150 technical brochure, or to book a Lunch & Learn session for your team, email engineeringsolutions@coates.com.au or call (02) 8796 5000.

"A combination of experimental and computational methods – including lighting fire lines of different shapes in controlled environments and measuring their characteristics using unmanned aerial vehicles equipped with infrared and visual cameras – is used," said Filkov.

"These capture high-definition video imagery of fire propagation in synchronisation with sensor data from the onboard Global Positioning System and inertial measurement unit."

They have also developed a custom-built fire package capable of measuring radiative and convective heat fluxes inside the fire, which they tested during the 2022 prescribed burning experiments in Victoria.

"By combining these data with physics-based modelling using computational fluid dynamics, we hope to further understand the mechanisms driving extreme and mega fires," he said.

Another aspect of Filkov's work that will contribute to fire preparedness focuses on exposure to firebrands – small, combustible fragments from an original fire – which are "responsible for at least 90 per cent of destroyed structures in wildland-urban interface fires", he said.

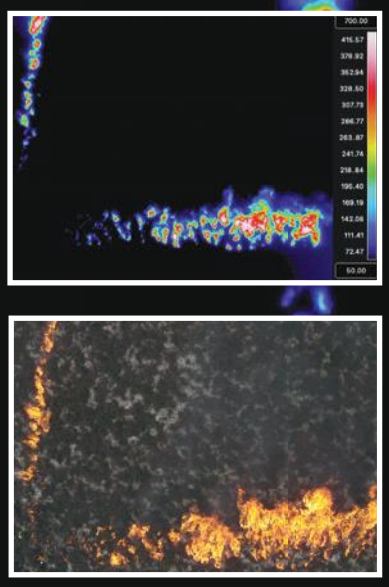
BELOW: Filkov's team has built a custom fire package to gather data about blazes.

He is leading a project in collaboration with the University of Maryland and the University of California Berkeley to determine the mechanism of ignition of building materials by firebrands, and to identify key building material properties that define their propensity to ignite when subjected to firebrand showers.

To achieve this, he developed a variable heat flux apparatus capable of simulating the dynamic radiant and convective exposures of fire.

"The knowledge gained from this project will help define critical conditions for ignition and sustained combustion of materials, and map firebrand safety zones around structures." ▸

"WHILE I WOULD SAY THAT THERE HAVE BEEN SIGNIFICANT ADVANCEMENTS IN OUR KNOWLEDGE OF BUSHFIRES, OVERALL, THERE IS STILL MUCH WORK TO BE DONE TO BE FULLY PREPARED FOR THE NEXT, LARGE WILDFIRE."



LEFT: Infrared imaging helps Filkov understand fire behaviour.

Catching fire

University of Melbourne Senior Research Fellow Alexander Filkov told *create* it is crucial to take an integrated approach that combines mechanical and fire safety engineering knowledge to better understand, predict and prevent the devastating consequences of bushfires.

"While I would say that there have been significant advancements in our knowledge of bushfires, overall, there is still much work to be done to be fully prepared for the next, large wildfire," he said.

He recently co-authored a paper on fire risk modelling for Kangaroo Island, based on the Black Summer 2019–20 fires, for the Bushfire and Natural Hazards Cooperative Research Centre using a "fire regime and operations simulation tool" to model fire risk for 12 regions in Victoria across 50 years.

It models three management scenarios: no planned burning, current rates of planned burning, and increased planned burning.

This aligns with research efforts to view land and fire management in a cross-cultural context, requiring a combination of traditional and local knowledge with science and technology to achieve the best results.

PLANNING FOR DAMAGE

RESEARCHING FIRES, floods, cyclones and other weather events is essential to understanding climate threats to human safety, said Lara Harland FIEAust CPEng, EnviroEngineering Solutions founder and immediate past chair of Engineers Australia's Environmental College.

However, the quickening pace of climate change means it is no longer always practical for engineers to design infrastructure to prevent failure.

"This is because the events will be so extreme that the cost, imposition and resources required to mitigate them will be prohibitive," Harland said.

This is an important area of focus for Engineers Australia.

"We will need to design for resilience where damage and time for recovery is minimised," she said.

"We also need to start having honest conversations with the community, advising that things will fail, and working with them to develop disaster management plans so we can better cope during the event, and recover faster after it."

Harland said engineers need to plan for failed infrastructure, such as mobile reception outage, internet availability and power failure.

"There will inevitably be increased heatwaves – before 2035 it is highly likely the western suburbs of Sydney will experience multiple days in a row of over 45 degrees and, due to poor planning and building practices, temperatures inside houses will be unliveable, likely causing unprecedented loss of human life. The current electricity grid will almost certainly fail, and serious upgrades are required immediately."

ABOVE: Higher temperatures will afflict Western Sydney in future. BELOW: More intense storms could lead to greater flooding.

Later this year, Harland and Steve Posselt of the Sustainable Engineering Society, a technical society of Engineers Australia, will lead an online course, "Defining the Problem", designed to help engineers understand, with probability and risk, the issues that need to be addressed when considering urban growth, biodiversity and global warming.

"With just 1.1 degree of global warming, we are seeing devastating effects everywhere," said Harland.

"Scientists agree we are locked into more than 1.5°C, even if we stopped all emissions yesterday, and some are predicting we will already reach 1.5 degrees by 2024," she said.

"We need to be having the hard conversations, not only about designing for resilience, but about the need to drastically cut emissions. We are no longer talking about our grandchildren; we are now living what scientists predicted half a century ago." ●

"WE NEED TO START HAVING HONEST CONVERSATIONS WITH THE COMMUNITY, ADVISING THAT THINGS WILL FAIL, AND WORKING WITH THEM TO DEVELOP DISASTER MANAGEMENT PLANS."

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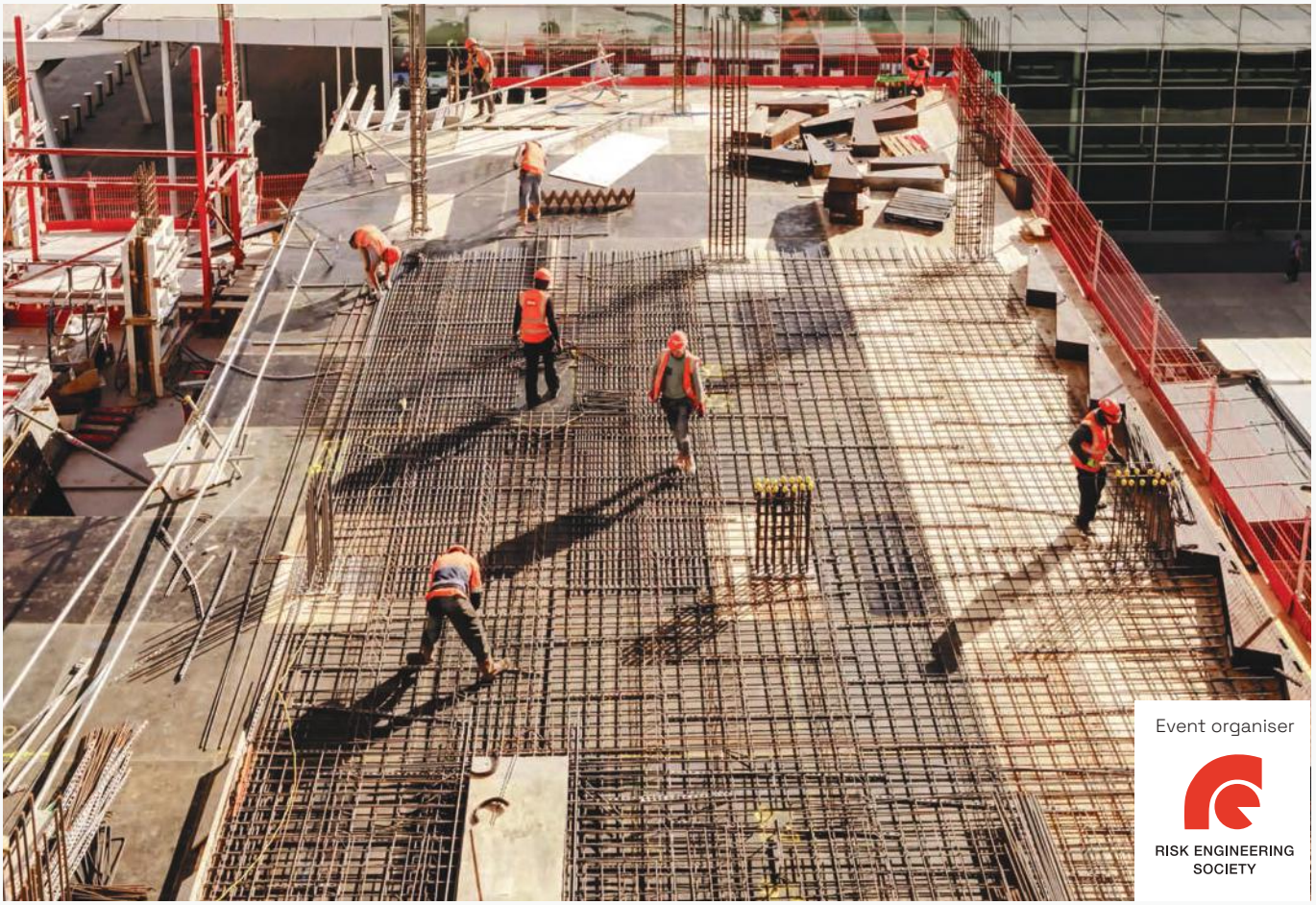

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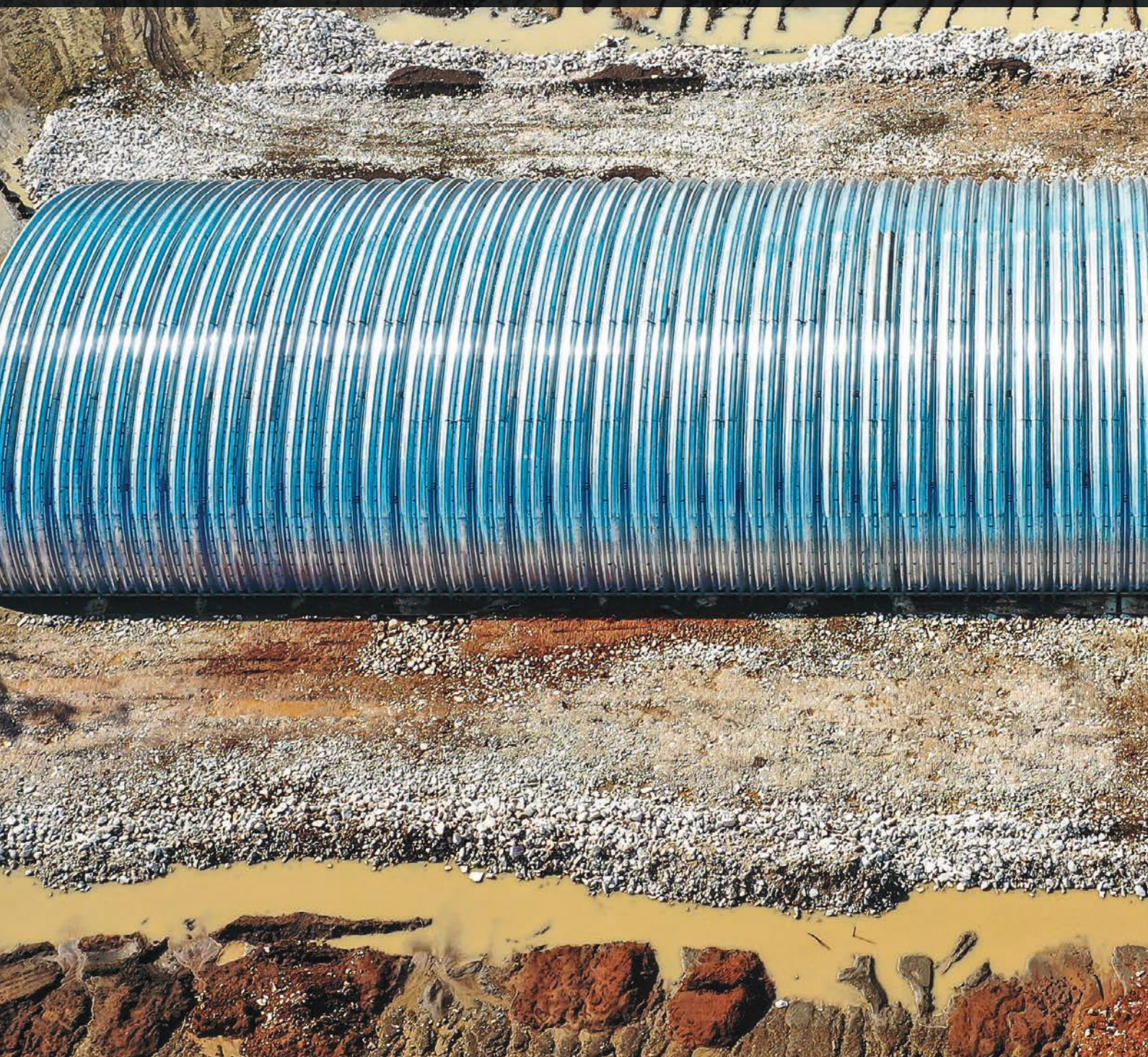

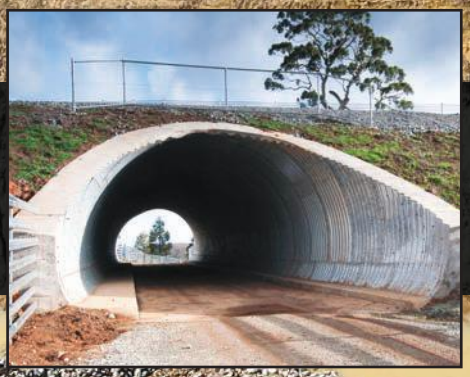

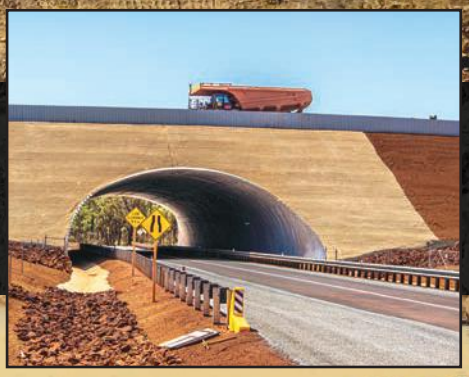

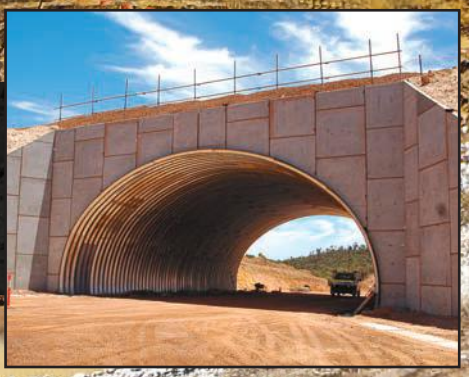

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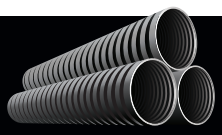

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WORDS BY **JONATHAN BRADLEY**

PHOTONIC FINISH

RECENT ADVANCES HAVE EXPANDED AN OLD MATERIAL BEYOND NICHE TELECOMMUNICATIONS APPLICATIONS AND PUT IT AT THE FOREFRONT OF A POTENTIALLY THRIVING NEW AUSTRALIAN INDUSTRY.

ABOVE: Lithium niobate can be integrated into silicon chips.

IMAGE: RMIT UNIVERSITY

WHEN LITHIUM niobate was first synthesised in 1949 at Bell Laboratories in the United States, the extent of the hopes of the engineers working on it were that it might prove useful in telecommunications.

The material appeared to have ferroelectric properties, allowing its polarity to be manipulated, and is piezoelectric, meaning a charge can induce movement in it – or vice versa. As researchers explored these properties, they began to introduce the material into a variety of technologies, and it became a well-established part of the telecommunications industry.

"There was one in every television by the 1970s," RMIT Distinguished Professor Arnan Mitchell told *create*.

"But they were niche applications. You have a lithium niobate device, and it does one thing; it's not an integrated circuit."

For integrated circuits, the basis of the sophisticated electronics that permit modern computing, silicon became the norm. But researchers like Mitchell, the Director of RMIT's Integrated Photonics and Applications Centre, thought lithium niobate still held potential.

For a start, it has valuable uses in photonics, due to its ability to produce and manipulate the full spectrum of electromagnetic waves, and not just visible light. And recent advances in manufacturing have meant it is much more feasible to produce it in a form suitable for semiconductor wafers.

"In the past, lithium niobate was available as a bulk material, so this

meant rather thick substrates, and what became recently possible is to have these as very thin films," Dr Andy Boes, a University of Adelaide Senior Lecturer who has been collaborating with Mitchell, told *create*. "This enables its integration with other platforms or confining the light and enabling these tight circuits to integrate more components."

It also means lithium niobate could address some of the shortcomings of silicon. In large data centres, for instance, the amount of information that needs to be transmitted demands the use of optical fibres.

"The industry is focused on adding photonics to silicon electronic chips, and this has become an industrial reality," Mitchell said.

"You essentially need a really high bandwidth communication system from every computer to every other computer, and so that is what's bringing photonics into the electronics world – the need to have all of these computers able to talk to each other in data centres and do this at a reasonable price."

That drove Mitchell and other photonics researchers to re-examine whether lithium niobate could have uses beyond its niche telecommunications applications.

"It's only really in the last five to 10 years that actual integrated circuits made out of lithium niobate and marrying them with silicon photonics have become possible," Mitchell said. "Let's go back to this tried-and-true material that's been used in bulk form and try and think about how it could be used the same way that people are now looking at integrated circuits and silicon. It seems that you can have the best of both worlds by bringing those two things together."

"LITHIUM NIOBATE WAS AVAILABLE AS A BULK MATERIAL. WHAT BECAME RECENTLY POSSIBLE IS TO HAVE THESE AS VERY THIN FILMS."

ABOVE: RMIT's Arnan Mitchell (left) and the University of Adelaide's Andy Boes.

IMAGE: UNIVERSITY OF ADELAIDE

BY MOONLIGHT

One company attracted by these possibilities is Advanced Navigation, an Australian robotics and artificial intelligence firm. It is using the lithium niobate chips developed at RMIT in its line of Boreas digital gyroscopes, which will help NASA vehicles navigate on the moon, where it is not possible to use GPS.

"Boreas is the first ever digital fibre optic gyroscope, and it has some pretty drastic advantages over traditional fibre optic gyroscopes," Xavier Orr, Advanced Navigation's CEO, told *create*. "That technology – part of which is born out of RMIT – will be the first Australian tech landing on the moon."

US aerospace company Intuitive Machines is building the lunar lander for NASA, and Advanced Navigation is contracted to provide it with the gyroscopes it will use in its navigation. Orr said that the lithium niobate chips allow them to be cheaper, use less power, and take up 40 per cent less space.

"That reduction in size, weight and power – the increased performance – represents about $85 million in cost savings when they launch," he said.

"To get to the moon, every gram has quite a high cost, so when you're able to cut size and weight down, it results in pretty substantial cost savings. And it also allows in new capabilities." ▸

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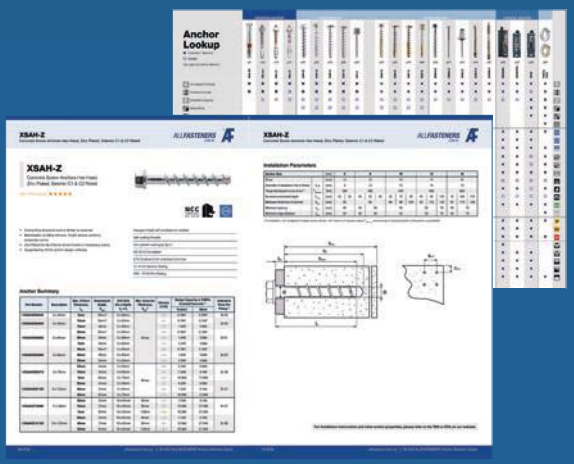

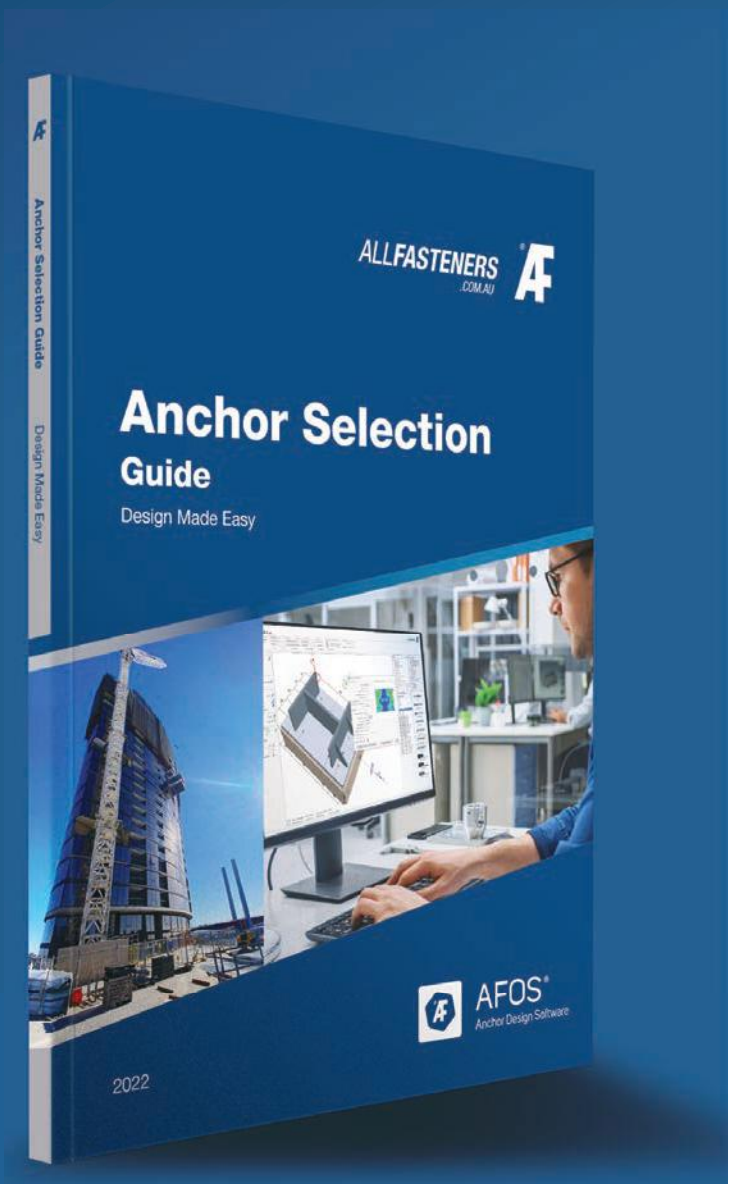

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These include an additional Intuitive Machines vehicle named the Hopper, which also uses Advanced Navigation's technology.

"It's utilising this D-FOG [digital fibre optic gyroscope] technology, as well as some of our other photonics technology," Orr said.

"It hops around the moon; it's doing little take-offs and landings again and again. So that kind of vehicle is really enabled by our technology."

To get the necessary precision for technology like this would require extremely high-precision fibres if analogue gyroscopes were used, Mitchell said. The digitisation offered by lithium niobate allows for more leeway.

"If you have digital signal processing then you can be a little bit less careful about it; you can use ordinary fibre, and you have better yield so you can wind them more easily and then just use digital signal processing to understand how each coil works," he explained.

"It becomes cheaper, so you can be a bit more aggressive in making the coils more compact; you can use more standard materials and use the information processing to overcome any imperfections in the materials.

"This is really what a complex integrated circuit allows you to do, and ultimately that makes it a bit more compact. So the structure can be quite a lot smaller and do all three axes with one chip rather than having a separate box for each, X, Y and Z axis."

While that reduced cost matters a lot when launching equipment into space, it also gives the technology a broader range of applications here on Earth. After all, most companies in the market for navigation equipment do not have a NASA-sized budget.

"Traditional fibre-optic gyroscopes, if you go and buy them, cost tens of thousands of dollars, and the idea is to reduce that by a factor of 10 so that you can start thinking about using these in many more applications," said Mitchell. "One of the companies we are working with does surveying with drones to look at the integrity of railway lines … You can have a cheaper drone with a cheaper navigation system on it and still get millimetre-scale accuracy information about where the rails are."

Terrestrial use is on Orr's mind too, and Advanced Navigation's Boreas gyroscope is finding use in a broad range of industries.

"We sell that into marine, automotive, aerospace applications, a lot of surveying applications and a lot of autonomous systems," he said.

"IT'S ONLY IN THE LAST FIVE TO 10 YEARS THAT ACTUAL INTEGRATED CIRCUITS MADE OUT OF LITHIUM NIOBATE AND MARRYING THEM WITH SILICON PHOTONICS HAVE BECOME POSSIBLE."

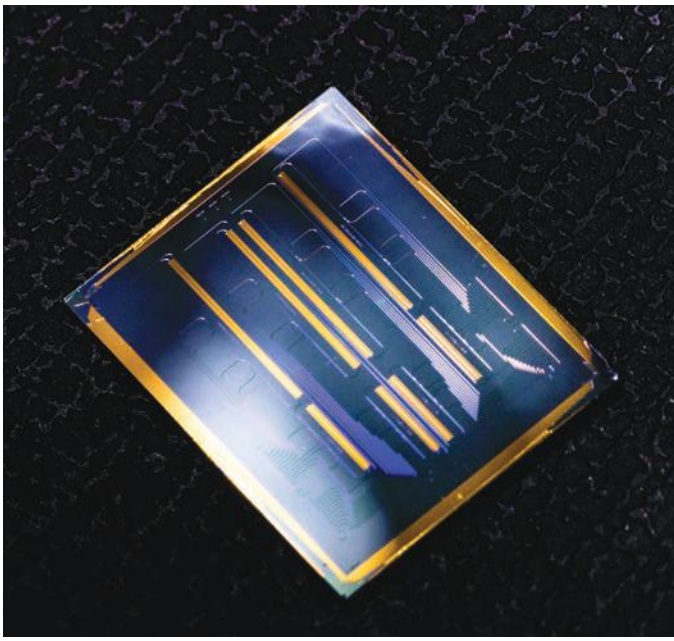
LOCAL HERO

A feature that could have positive long-term implications for local industry, and one that is important to Advanced Navigation, is that the lithium niobate chips are produced in Australia – right there at RMIT.

"The D-FOG technology is seen as a sovereign capability by the Australian government," Orr said.

"So there's a real desire to keep that all onshore and have them fully built here."

When Advanced Navigation took this requirement to Mitchell and Boes's team, the academics used the opportunity to let them know how much more they could do for the company.



ABOVE: A lithium niobate optical chip.

ABOVE: Xavier Orr, Advanced Navigation.

IMAGE: RMIT UNIVERSITY

Ripe with potential

Distinguished Professor Arnan Mitchell and Dr Andy Boes both emphasise the range of possibilities opened up by lithium niobate photonic chips.

"It is great for doing information processing, but it can work over a much wider range of wavelengths, so you can do everything from ultraviolet light through to visible," Mitchell said.

"You can use it for creating light at those wavelengths or synchronising lasers at different wavelengths. So it's a very, very powerful tool for manipulating light."

One arena in which these properties have found use is agriculture: researchers are using the material to measure the presence of ethylene, a gas released by fruit as it ripens.

"If you can measure carbon dioxide, oxygen, ethylene, other things in the gases environment, you can detect the status of trees," Mitchell said.

"It's up in the mid-infrared [range] that you can't see with your eyes – it's not quite up to heat, but it's in that regime. But lithium niobate can actually operate in that level."

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Dulux® Protective Coatings is proud to have partnered with McElligotts on one of Australia's largest steel maintenance projects – the West Gate Bridge.

Built in the 1970's, this Melbourne icon was coated with Dulux Protective Coatings and now 40 years on it was time for a remediation project.

Exposed to pollution from traffic and sea water the West Gate Bridge required superior protection. For the 800m-long steel deck, Dulux Protective Coatings along with Mark Dromgool of KTA-Tator Australia specified a four-part coatings system, plus a special stripe coat for more than 120,000 bolts!

After extensive product trials by the McElligotts team, Dulux's durable system was chosen as the fastest drying solution with the best finish. Here are the steps in our specification:

BLAST: The 800m long steel deck had a total of 60,000 square meters to repaint. The underside of the steel deck was abrasive blast cleaned.

PRIME & FIRST COAT: Zincanode® 402 was applied with a Cold Cure Hardener. The two-pack epoxy zinc rich primer is ideal for use over abrasive blast cleaned steel.

SECOND COAT: The second coat of surface tolerant epoxy Durebild® STE was then applied.

THIRD COAT: Durebild® STE MIO added a layer of surface tolerant micaceous iron oxide, working as a barrier coat for protection against water ingress.

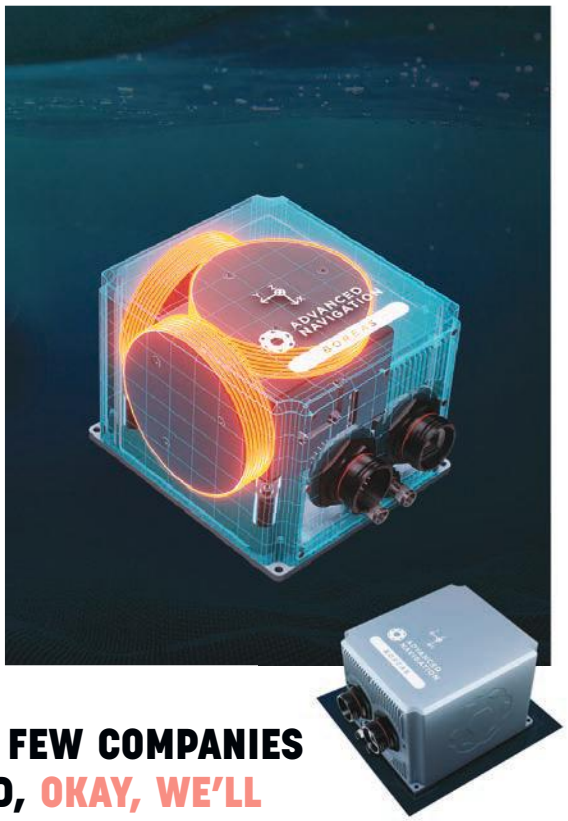
FINISH: A final topcoat of Weathermax® HBR MIO ensured a high build finish.

"We said, 'Well yes, we could do that, but you might be interested to know that it's now possible to make much more complicated integrated circuits and so we could think about more sophisticated systems than what people have been doing for 30 years,'" Mitchell said.

"This is what we've been doing with Advanced Navigation – and also researchers at ANU [the Australian National University], who have more sophisticated sensing mechanisms using digital information processing."

Orr also appreciates how closely his company can work with the university researchers.

"They produced all the prototypes at that facility for us, which allowed us to do the testing really quickly," he said.



"THEY'RE ONE OF THE FEW COMPANIES THAT HAS REALLY SAID, OKAY, WE'LL TAKE A PUNT, AND WE'LL ACTUALLY STEP INTO THAT VALLEY OF DEATH WITH YOU."

THE "VALLEY OF DEATH"

Mitchell sees the collaboration as one of a type that should play a bigger role in Australia's industrial landscape. He believes that while the country has a solid research base, it's lacking the funding and institutional support that can take innovations to fully developed technology ready for exploitation.

"To give Advanced Navigation their due, they're one of the few companies that has really said, okay, we'll take a punt, and we'll actually step into that valley of death with you if you'll meet us halfway," he said. "This is what Europe and America do differently to Australia: they focus a lot of their resources – their government resources – on filling that gap."

Orr sees these collaborations as working well for everyone.

"A university might have been working on something for 10, 15, 20 years and it's a really deep technology that takes a very long time to develop, and then they have incredible results that can really change a whole industry," he said.

That's why Mitchell and Boes hope more businesses think about what they could do with lithium niobate chips. Mitchell estimates that around 100 companies in Australia could use the technology, enough to build a local industry.

"We are probably still talking about, ambitiously, tens to hundreds of thousands of [chips] a year, and at the chip level we could probably almost push out that many chips with a facility about the size of the one we've got at RMIT University," he said.

Boes also sees opportunity for ambitious companies.

"[Get] familiar with what is currently possible, but also what will be possible in the near future," he urged. "There are lots of opportunities in this space." ●

ABOVE: Advanced Navigation's Boreas digital gyroscope.

Light touch

Advanced Navigation's digital fibre optic gyroscope technology has a lot of advantages: in cost, in weight, in size. To achieve this, the company had to make use of the way lithium niobate chips interact with light.

Fibre optic gyroscopes, explained RMIT Distinguished Professor Arnan Mitchell, are a kind of movement sensor.

"You have a long fibre spool, and if you rotate it, the path that the light takes going in one direction is slightly longer than the path that the light takes going in the other direction due to – believe it or not – Einstein's [theory of] relativity," he said.

"You're trying to measure that small change."

Analogue gyroscopes have used lithium niobate to make these measurements for decades, but the digital circuitry that comes from integrating the material into a chip allows the device to measure multiple kinds of data at once.

"It's this marriage of silicon electronics and lithium niobate technology," Mitchell said.

"We are enabling Advanced Navigation to have a more sophisticated gyroscope offering."

WORDS BY **COLE LATIMER**

ANYTHING BUT CHILD'S PLAY

THEY MAY BE LARGELY UNSEEN, BUT THE ENGINEERS WHO BRING TOYS TO LIFE HAVE A UNIQUE SET OF CHALLENGES.

ALL ENGINEERS face two key challenges: to devise solutions that work and that can cope with the rigours of their environment. Their creations must be tough enough, and capable enough, of doing what they need to do.

But for one set of engineers, there's an additional and unique challenge: to make it fun.

And while toy engineers may not be as visible as their colleagues, their creations are some of the most used on a daily basis by a particularly dedicated user base. They strive to apply their maths and engineering skills to making products that are not only durable, but entertaining and affordable.

ABOVE: "Toyologists" blend engineering and fun.

This is especially the case with toys that seek to blend engineering and fun into commercial products, such as those of family-owned Australian companies Moose Toys and KidzInc. These companies' engineers and "toyologists" use their skills to build and supply a range of different toys to entertain, educate, and engage children.

Moose is one of Australia's largest toy companies and whose range extends from Shopkins to the worldwide success that is *Bluey*. Its designers are based in Melbourne, the UK, Germany, France, China, Hong Kong and Los Angeles.

For Carl Budd, Engineering Manager at Moose Toys, it began well outside the world of toys.

"Most of my previous life was spent in the design of medical devices, sometimes at the R&D end and sometimes in the manufacturing side," Budd told *create*.

"I also spent a few years in the oil and gas industry, and industrial automation – industries where every stage of development has to be performed to the nth-degree, and documented, reviewed and tested.

"This was a great foundation for understanding how to separate what steps must be done, and what steps can be left out in order to arrive at a functional, workable solution as quickly as possible.

"Exposure to various disciplines, such as mechanical design, industrial design, electronics and software design in my earlier career, has given me the skillset to take on the challenges of engineering for toys."

CREATIVITY AND PLAY

One skill Budd had to learn on the job was how to make fun.

"A toy engineer helps to bring a fun and playful idea into existence," he said.

"We take imaginary concepts and turn them into a physical, manufactured product, while doing our utmost not to lose any of the magic along the way."

Magic aside, Budd explains the engineering process is much like regular product development, but on a faster timeline, and with a different testing audience: kids.

"Testing with actual kids along the way is essential," he said.

"PRACTISE APPROACHING EVERY PROBLEM FROM A FRESH ANGLE, MAKE A HOBBY OF BEING CREATIVE. AND NEVER STOP HAVING FUN."

"Durability is a fun challenge; you can spend hours thinking of all the imaginative ways kids might push, pull, step on your design, only to be surprised when they try to give it a bath instead."

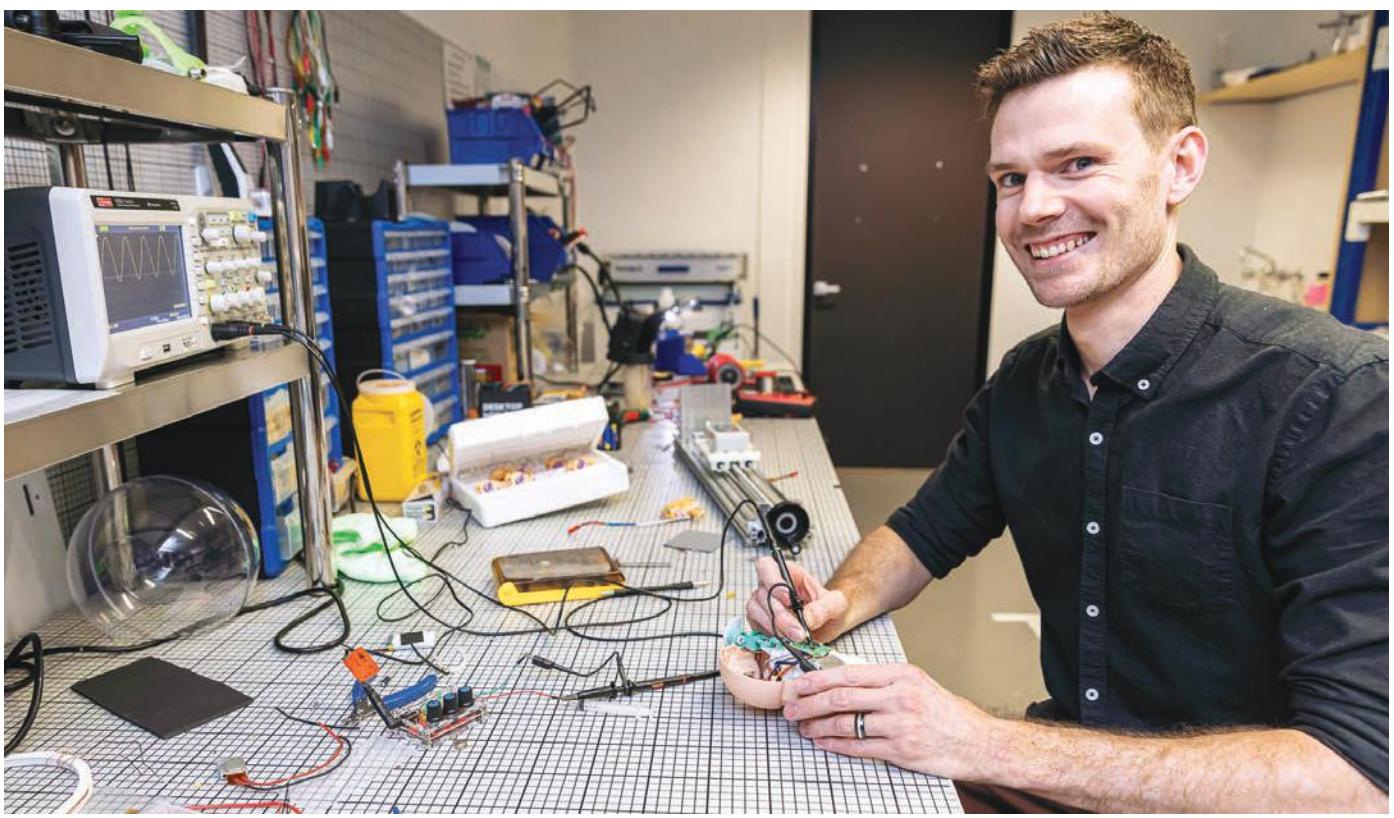
New developments typically start with initial brainstorms and sketches. The process then moves to computer-aided design before prototyping, using in-house 3D printing and electronics capabilities.

After that, it goes through a number of iterations to meet the needs of stakeholders, including designers, licensors, retailers and children, all while considering compliance, safety and cost factors.

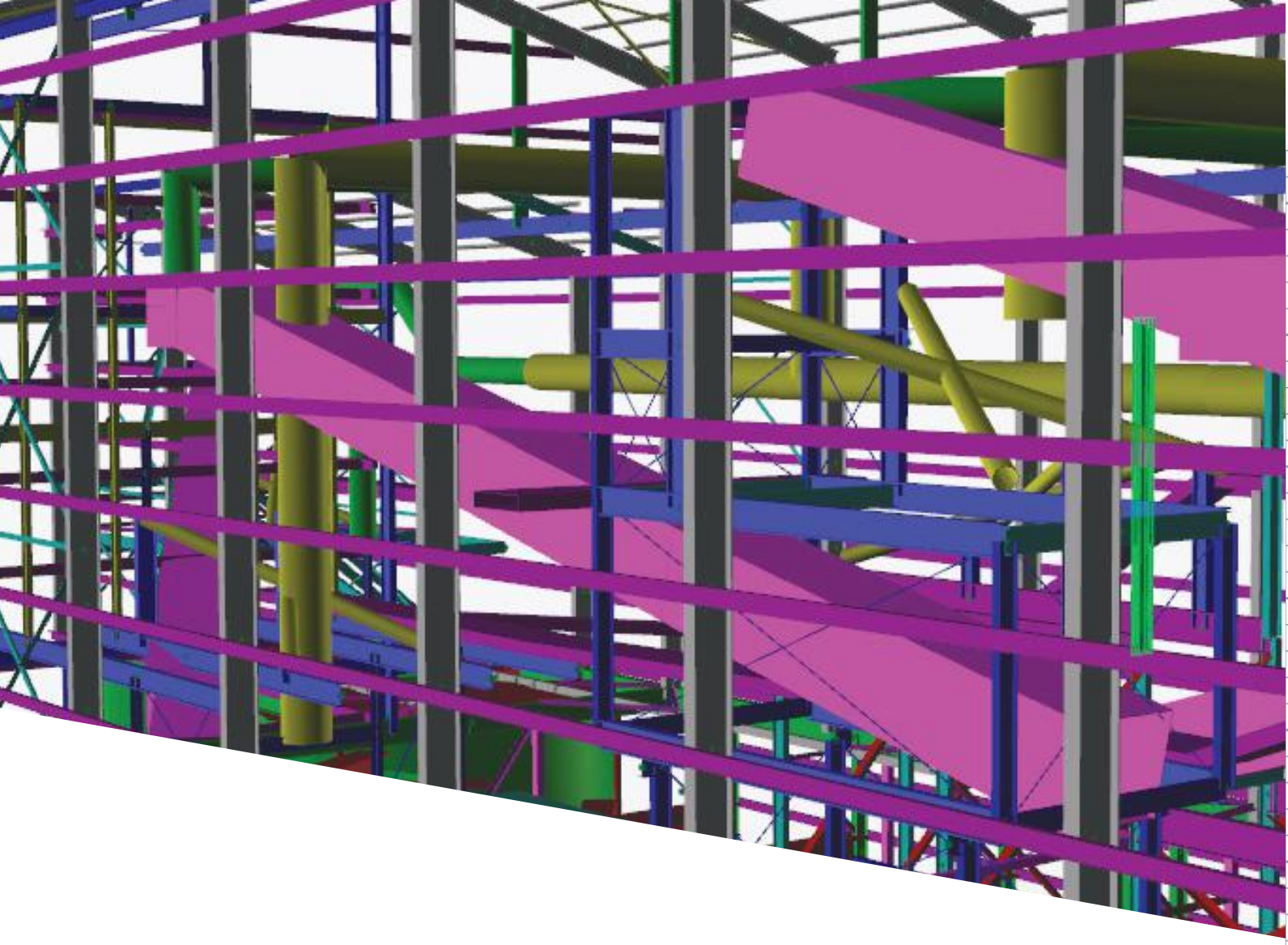
Budd explained that cost is a major factor in toy engineering, because "anything is possible if you have the budget".

"But any consumer good has to be affordable if you want to sell many of them," he said.

"Distilling the most fun elements of an idea into an affordable product takes a lot of effort." ▸



BELOW: Carl Budd, Moose Toys.



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"TOYOLOGY IS A MULTIDISCIPLINARY FIELD THAT COMBINES VARIOUS AREAS OF EXPERTISE, SUCH AS CHILD DEVELOPMENT, PSYCHOLOGY, DESIGN, ENGINEERING, MARKETING AND BUSINESS."

He said one of the largest industry shifts he is seeing is towards greater sustainability, which is coming not just from regulatory bodies but also consumers demanding "guilt-free" products that use greener materials, more sustainable packaging and improved manufacturing.

Despite these challenges, Budd said he loves the industry, and if asked for one piece of advice for aspiring toy engineers, suggests: "Don't get comfortable doing only one thing really well".

"Practise approaching every problem from a fresh angle. Make a hobby of being creative," he said.

"And never stop having fun."

PLAY AND INSPIRATION

Lubica Misevski, owner and Chief Toyologist for KidzInc, focuses on providing toys that lay the foundation for the next generation of engineers through early exposure to STEM skills.

Prior to her current role, Misevski had trained as a mathematician and was a business consultant, analysing processes and systems to identify inefficiencies or areas for improvement, and creating strategies to optimise these processes and procedures.

While Misevski doesn't design the toys herself, she uses her analytical background to discover the best STEM-focused toys to improve children's IQ, EQ and even "FQ" – or financial intelligence.

"Toyology is a multidisciplinary field that combines various areas of expertise, such as child development, psychology, design, engineering, marketing and business," Misevski said.

"Many toy manufacturers and educational organisations have partnered to create programs and resources that promote STEM education, such as coding classes and STEM camps.

"These initiatives are designed to expose children to STEM concepts at an early age and encourage them to pursue STEM fields in the future."

FUN AND FUTURE-FOCUSED

Lubica Misevski of KidzInc says that when designing toys that stand out, it is essential to strike a balance between aesthetics, function and safety — and to use science and engineering principles to create toys that promote learning, creativity, and imagination in children.

One of the major shifts Misevski has seen in toy engineering, along with an increasing emphasis on sustainability, is more integration of technology.

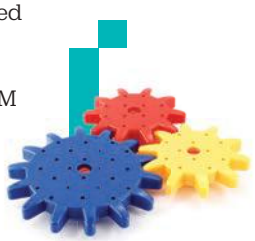
Toy engineers are incorporating such advancements as artificial intelligence, augmented reality and robotics to enhance the play experience and provide new learning opportunities.

"Some STEM-focused toys include building sets, coding, robotics and science experiment kits," she said.

"These toys allow children to explore STEM concepts in a hands-on and interactive way, which can help them to understand better and retain the information."

ABOVE: An end-user tries out a toyologist's creation.

ABOVE: Lubica Misevski, KidzInc.



This is increasingly important, since it is predicted that workers of the future will spend more than twice as much time on tasks that need STEM skills than they do today.

Toy engineers may be one of the profession's "hidden" engineers, but their impact and efforts in designing and creating toys that are durable and sustainable enough to not only entertain, but also educate the next generation, plays a special part in shaping a better future. ●

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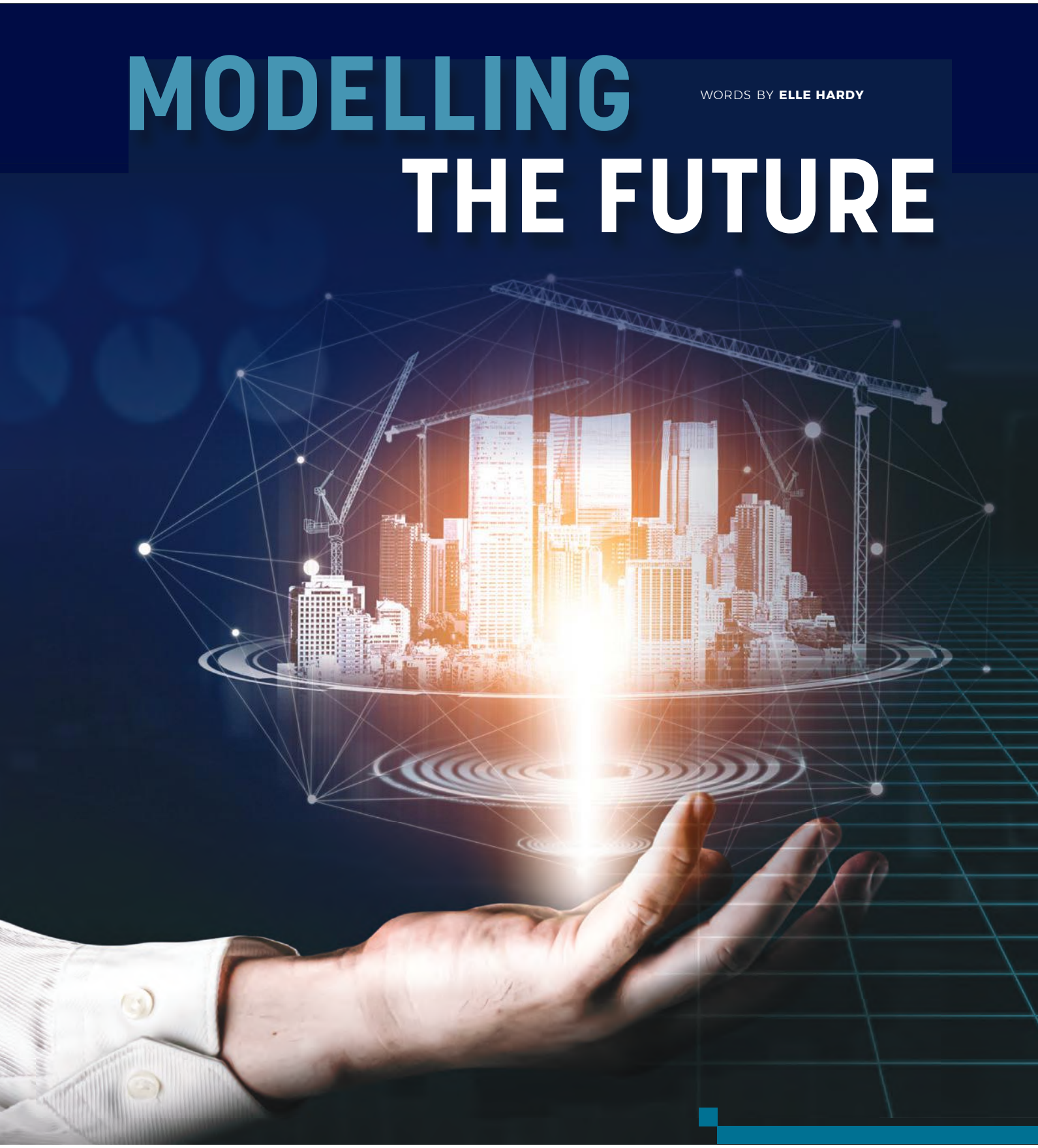


TIM MUMFORD BELIEVES THAT DIGITAL ENGINEERING TOOLS CAN TAKE PRODUCTIVITY TO THE NEXT LEVEL.

ABOVE: Tim Mumford, Beca. BELOW: Using digital modelling for a project.

IN ENGINEERS Australia's recent *Future of Transport* white paper, the authors argue that the use of digital infrastructure solutions will future-proof Australia.

However, it's not simply a matter of plug-and-play.

"Greater emphasis is needed on integrating nationally consistent digital approaches to public infrastructure planning and operations," the authors warned, "if Australia is going to be ready for the demands of the future."

One engineering leader doing just that is Tim Mumford CPEng, Beca's business director for digital and innovation, with a background of working in business and government.

He told *create* that "digital engineering is the nirvana we need to head toward".

"Digital engineering is the integration of structured information into 'object-oriented' models," he said. "These are highly valuable in both the capital and operations phases of an asset's life."

ONLY THE BEGINNING

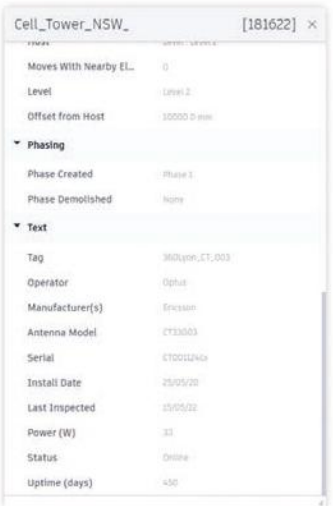
Mumford stresses that digital engineering isn't bound by technology, but requires a mindset shift to usher in a better way of working.

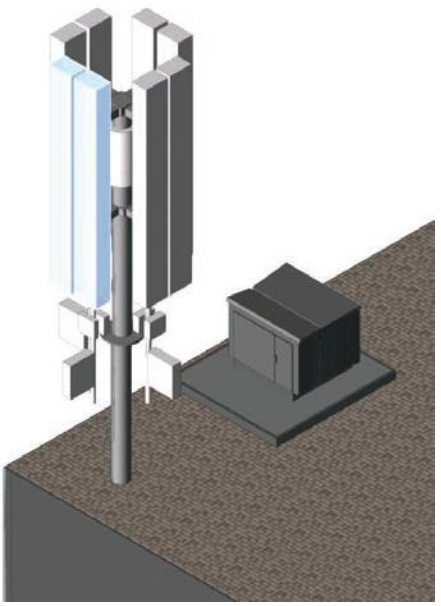
At present, the industry has only begun the shift into a digitisation phase.

"We've transferred our paper-based environment to digital representations of the same thing," he said, "but they retain many of the hallmarks of paper-based processes, in that they're difficult to search and understand trends, and they're not dynamic."

Take, for example, traffic lights on a prospective road project, designed on software that might export to paper or PDF. ▸

"DIGITAL TRANSFORMATION HAS THE POTENTIAL TO BOTH DRIVE DOWN COSTS IN THE CONSTRUCTION AND OPERATION OF BUILT ASSETS AND DRIVE UP QUALITY."





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ENGINEERS AUSTRALIA

"To a computer, they're just lines on paper – it doesn't know it's a traffic light," Mumford said.

"The ideal world for digital engineering is one where, if you change anything about that same road, such as its alignment, it automatically moves the light pole with it. Or you delete the light pole, it changes the cost estimate."

While some in the field are already beginning to adapt to this smarter way of working, Mumford urges consistency and acceleration.

"From fabricators, to construction managers, to designers, to bureaucrats, to ministers, we all have a role to play," he said.

"The economic benefits are there in black and white."

PRODUCTIVITY PRIORITY

A 2022 report commissioned by the University of Cambridge's Centre for Digital Built Britain found that "digital transformation has the potential to both drive down costs in the construction and operation of built assets and drive up quality".

The authors outlined that an effective information management framework leads to direct productivity gains for organisations, increased growth across the wider economy and social value to customers, society and the environment.

This sentiment was echoed in last year's Infrastructure Australia roadmap, which said that "transformational change is needed in how we plan and deliver infrastructure in Australia".

Three of the seven focus areas for reform outlined in the roadmap – systems, digital and collaboration – are all areas in which digital engineering can play a key role.

"If we don't reform ourselves as an industry, we will get to a natural precipice of governments saying, 'we can't afford it'," Mumford said.

He noted that Australia's infrastructure and construction sector lags the entire economy, becoming 25 per cent less productive over the past 30 years. Worryingly, infrastructure businesses are among the least likely to invest in innovation.

"Our sector is the least digitised in Australia," Mumford said; infrastructure lags industries including manufacturing, retail and agriculture.

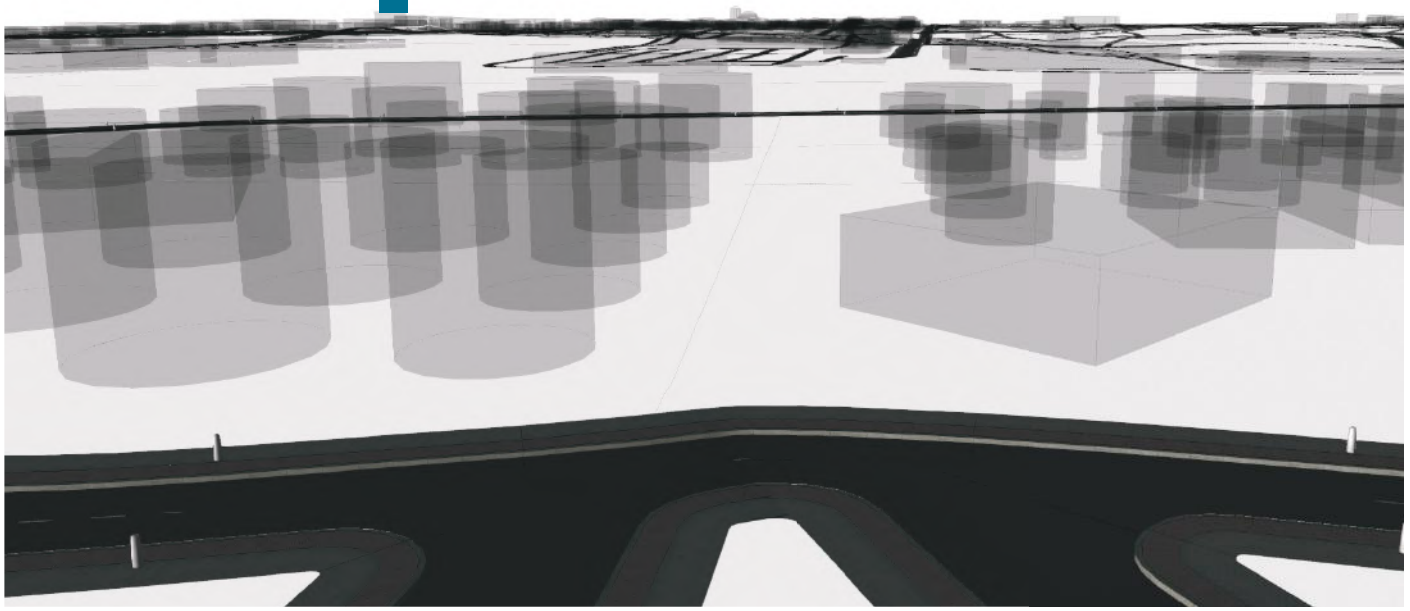
The correlation between productivity and adoption of digital is no coincidence.

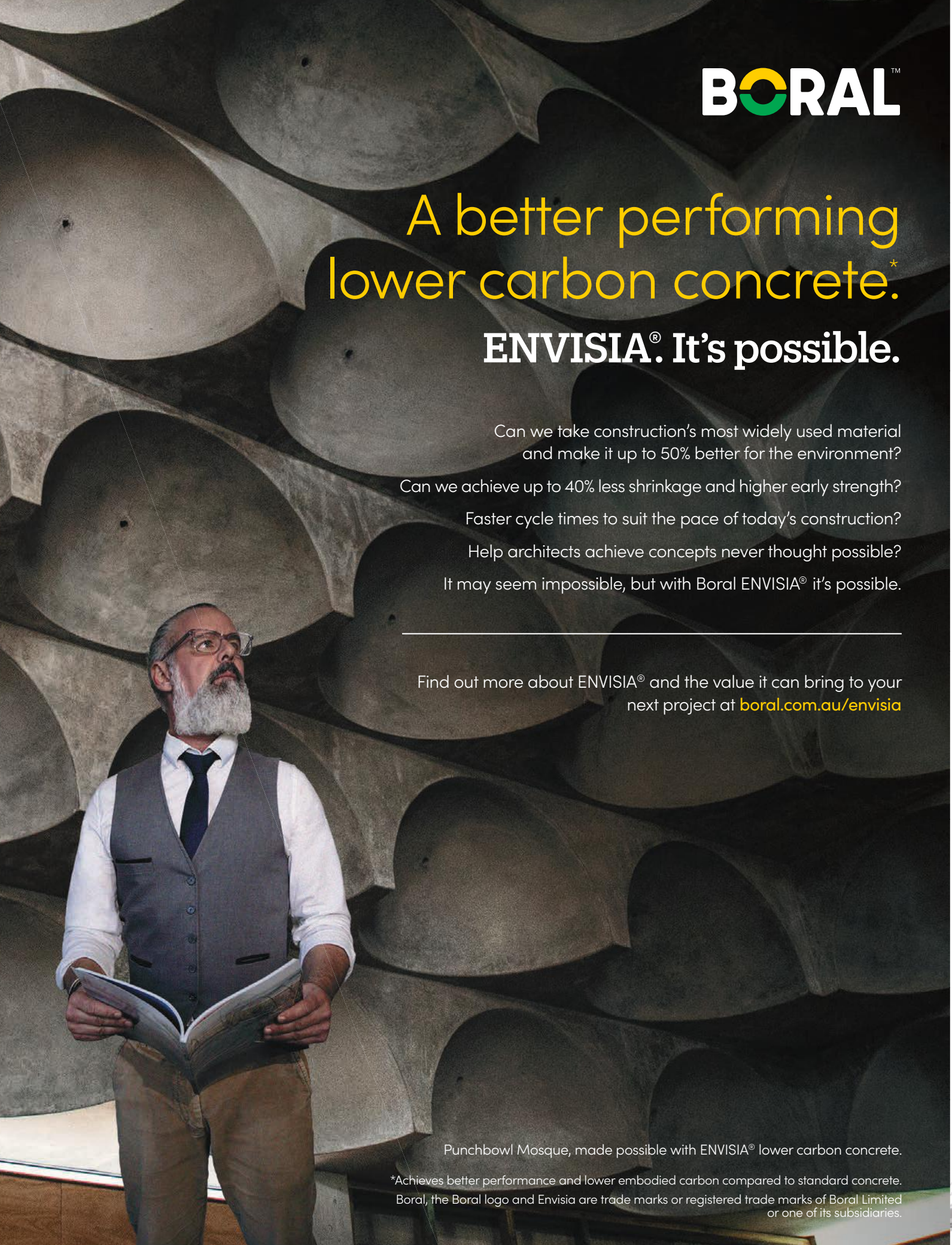
"The entire economy is adopting new and more productive ways of working, but we're still using paper," he said.

"It makes total sense that we're struggling to keep up.

"We all have a responsibility to think about existential issues in the industry, just like we do for environmental safety, standards and accountability. It's not something that can be done by committee; we need to ➤

"THE ENTIRE ECONOMY IS ADOPTING NEW AND MORE PRODUCTIVE WAYS OF WORKING, BUT WE'RE STILL USING PAPER."

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seek productivity and progress through education."

One positive on this front is that governments are recognising the benefits of digital engineering to industry, society and the economy.

"Victoria, New South Wales and Queensland have been early adopters," Mumford said. "And the progress is looking promising."

DEFAULTING TO DIGITAL

Sustained and industry-wide change that makes a digital approach 'business as usual' will still take some effort.

"The challenge we face is the inherent nature of our sector," Mumford said.

"Projects frequently take over five years, and the people starting the project are often not there at the end."

Mumford believes organisations also need to consider better ways of working.

He points to the legal "deliverable" for many project contracts for thousands of two-dimensional PDF drawings.

"Right now, as an industry, we're creating those documents from 3D models," he said.

"We're essentially going back a dimension and throwing the 3D model in the bin at the end of the project."

Many of these two-dimensional drawings are rarely accessed. On one project, Beca found only 10 per cent of historical drawings were opened in the 10 years after the project was completed.

"Clients often approach us to accelerate projects, and one way in which we've been able to halve the timeline is by delivering a 'model-first' approach," he said.

"The first time is a learning curve, but after a while, it becomes a new, better normal."

With all of the risks inherent in major projects, Mumford believes digital engineering can be a kind of "project campfire to join the dots" between siloed departments.

"Projects and assets are getting more complex, but I am certain that digital can make our jobs easier," he said.

"I'm excited about what that means for us – not just as a sector, but also as a society." ●

"CLIENTS OFTEN APPROACH US TO ACCELERATE PROJECTS, AND ONE WAY IN WHICH WE'VE BEEN ABLE TO HALVE THE TIMELINE IS BY DELIVERING A 'MODEL-FIRST' APPROACH."

CULTURAL SHIFT

Driving sustained digital change is hard, said Tim Mumford, Beca's business director for digital and innovation, but engineers can learn from other sectors.

"Safety became everyone's responsibility in the '90s through legislative reforms," Mumford said.

He recalls seeing banners across building site entrances as a young field engineer, such as "Who are you going to look out for today?" and "Everyone goes home safe".

Mumford believes that this campaign of bringing workers into the accountability process helped change workplace culture.

"I remember thinking that safety is my responsibility — and if I don't drive it, it won't change," he said.

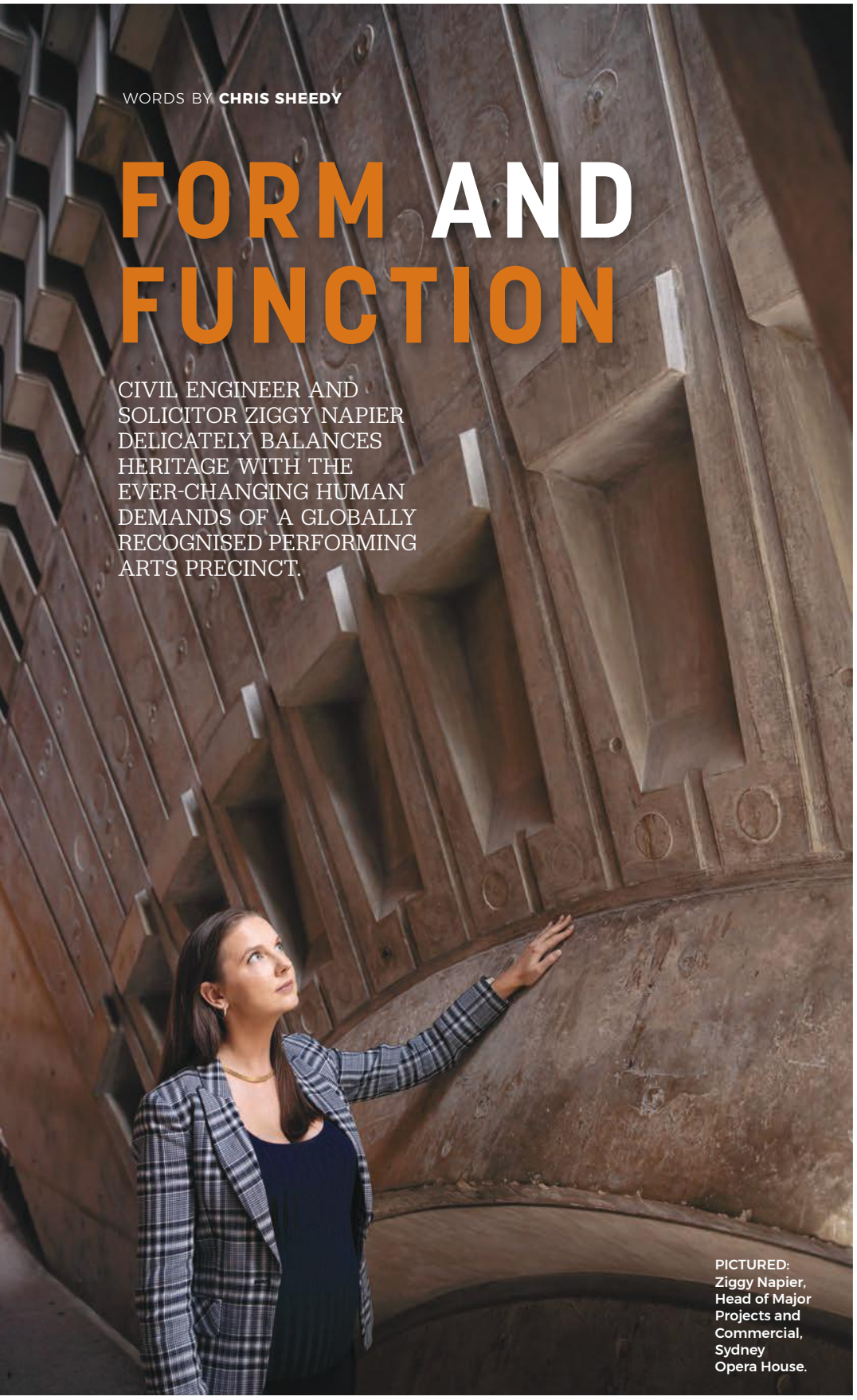
This cultural reset is evidenced in the fact that, since the early 2000s, there has been a sustained decline in workplace safety incidents and claims.

Mumford said that the industry should take a leaf out of safety's book when it comes to digital innovation.

"There could be a personal accountability model driving digital innovation on an individual level to reverse the productivity issue," he said.

It could begin with simple steps such as engineers auditing daily tasks and assessing which could be automated or requesting that information is delivered in a more efficient manner.

Engineers could also learn a computer coding language or work with a digital expert in their organisation for advice on which technologies could improve their performance.



WORDS BY **CHRIS SHEEDY**

FORM AND FUNCTION

CIVIL ENGINEER AND SOLICITOR ZIGGY NAPIER DELICATELY BALANCES HERITAGE WITH THE EVER-CHANGING HUMAN DEMANDS OF A GLOBALLY RECOGNISED PERFORMING ARTS PRECINCT.

PICTURED: Ziggy Napier, Head of Major Projects and Commercial, Sydney Opera House.

WHEN THE Sydney Opera House underwent major renewal works, the Concert Hall closed for more than two years.

To fill that gaping hole, a new digital, immersive venue and experience was created for tour patrons.

It involved converting back-of-house storerooms, a cool room, and an office space into a state-of-the-art, 30-person venue.

The build was undertaken in line with the Opera House's Conservation Management Plan and architect Jørn Utzon's design principles, which say that the architecture should be "predominantly experiential in nature".

With the creation of the new venue, the "experiential" box was well and truly ticked. Music was commissioned, and visuals were developed to surround the audience.

These showed the evolution of the Opera House on a 270-degree digital projection, focusing on the Concert Hall and its many performers, from early times to the modern day.

"I was told a story about a member of the public who took an Opera House tour and who burst into tears at the end of the digital projection," said Ziggy Napier, Head of Major Projects and Commercial at the Sydney Opera House.

"It wasn't just because it showed the beauty of the Opera House. It also showed how important the building is to the surrounding harbour. It showed the history and the power of performance – there's so much history that has gone through that hall. I completely understand how someone could be so moved by that experience."

LIVING ARCHITECTURE

Napier finds it easy to become philosophical when considering the challenges of her role, looking

at her work from beyond the logical and scientific perspective of a seasoned engineer.

"People think it's all about the heritage of the building," she said. "And the heritage of a building is typically just about bricks and mortar.

"But the heritage aspect of the Opera House is not just its bricks and mortar. Part of our heritage is in our continued function and use as a performing arts centre. So we always have this balance to strike between preserving the heritage fabric of the building, and ensuring that it continues to be a performing arts precinct – one that everyone can access."

With accessibility a central concern of every renewal project at the Opera House, a major challenge is reconciling the intangible and very human needs of performance with the physical impact that comes with making changes and repurposing spaces.

"There's a lovely, succinct letter Utzon wrote to the chairman of the day, where he said, 'The Opera House is a multi-purpose structure that will, in time, undergo many natural changes, and will need to continue to evolve to meet the changing needs of performers and the community,'" Napier said.

"WE ALWAYS HAVE THIS BALANCE TO STRIKE BETWEEN PRESERVING THE HERITAGE FABRIC OF THE BUILDING AND ENSURING THAT IT CONTINUES TO BE A PERFORMING ARTS PRECINCT."

The needs of performers and the community have changed significantly since the Opera House was built, she added.

As an example, Napier said, at the time of the Opera House's construction, accessibility and inclusion were not at the forefront of designers' minds.

Hence, there are 172 steps from the forecourt to the Concert Hall's northern foyers and 156 steps from the forecourt to the Joan Sutherland Theatre's foyer.

"If you've ever had a knee or hip injury, or you know anybody with mobility issues, you know that steps are a nightmare," she said.

"We have to make changes to the building so all people, regardless of mobility, can enjoy performances or have a meal or a drink."

The past five years have focused on making those improvements, including installing three glass lifts in the façade of the building – glass being used specifically to blend seamlessly into the heritage building – as well as two new passageways.

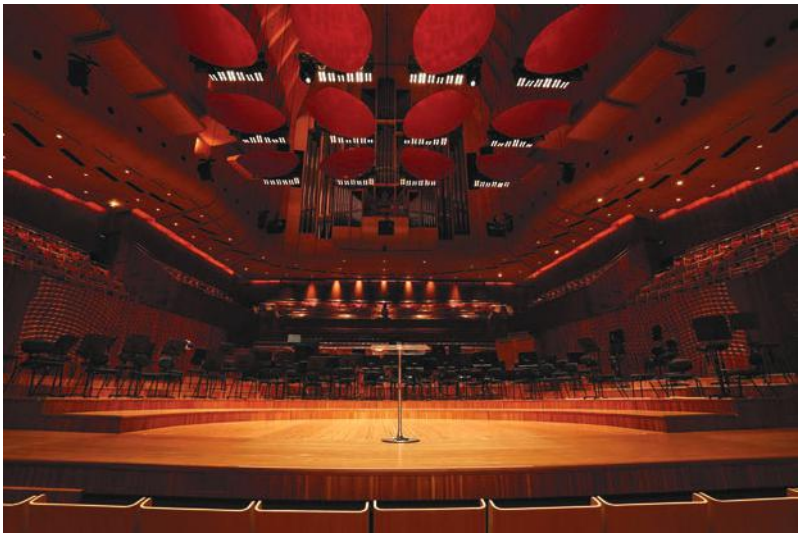
Collectively, these improvements ensure people with impaired mobility can independently access all levels of the Concert Hall and the Joan Sutherland Theatre.

"This means some people can access these spaces for the very first time," Napier said.

"Accessibility changes are so important. They mean this building, and everything in it, is relevant to the entire community."

EXTRA-VIRGIN OPERA HOUSE

Another consideration is the fact that many physical aspects of the Opera House are one-of-a-kind. It's a challenge that has caused Napier some angst, particularly when she was first invited to take the role six years ago.



ABOVE (from top): The Sydney Opera House Concert Hall; renovations integrated glass lifts to blend in with the façade; Opera House fixtures are constructed from a bronze alloy specific to the Opera House.

Now, she takes it in her stride.

"There isn't any commonality between this building and other cultural institutions, or other buildings in the world, let alone in Sydney," she said.

"We have thousands of metres of extruded bronze handrails, inside and outside the building. The entire façade is also made of bronze, as are our bollards, screw fixings, light rails, door frames and lamp posts.

"And it's a very specific, Opera House alloy. It's our very own mix."

To add to the challenge, bronze isn't a commonly used metal these days. ▸

IMAGE: LISA MAREE WILLIAMS, GETTY IMAGES FOR SYDNEY OPERA HOUSE; ANNA KUCERA; CHRIS BENNETT

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"We don't have many craftsmen today that use the same techniques from the 1960s and 1970s, particularly the linishing and ageing process," she said.

"This is a challenge of a lot of the building fabric here."

It even affects the cleaning, Napier said. The bronze is only ever cleaned with olive oil, never with harsh chemicals or solvents that could degrade or impact the longevity of the building.

The mix of engineering and law is a potent one, Napier has discovered. She walks a tightrope between engineering and commercial demands when it comes to managing multimillion-dollar contracts to ensure the World Heritage-listed building, which is nearing 50 years old, is maintained and cared for.

"It's not enough to have a brilliantly executed project of high quality if it isn't delivered on time and to budget," she said.

"That's where you see that interplay between the engineering, technical, legal and commercial. I've been very fortunate in the roles that I've taken, and the experience and the skills that I've gained."

Napier's resume includes years as a solicitor in law firms; as an engineer with engineering firms and contractors; and as an associate advising public and private sectors in transaction management and project delivery at Advisian.

"WE DON'T HAVE MANY CRAFTSMEN TODAY THAT USE THE SAME TECHNIQUES FROM THE 1960S AND 1970S. THIS IS A CHALLENGE OF A LOT OF THE BUILDING FABRIC HERE."

"I now look after engineers, project and commercial managers, and technical specialists," she said.

"The ability to speak in their languages really helps to get messages across clearly."

BY THE BOOK

As well as being a trained engineer, Napier studied law in a double degree.

"I loved the humanities, was good at English and enjoyed philosophy," she said.

"I thought, well, law is the vocational option where you get to study jurisprudence, which is the philosophy of law. Law is very much about your ability to communicate, whether written or verbal. It is very analytical and requires you to be able to describe complex concepts in simple ways, and there's a lot of wordplay and mental gymnastics with contract drafting."

Those choices led to Napier helping to look after one of the world's most significant buildings.

"It's vitally important that I get this right," Napier said. "If I'm completely honest, I don't think I fully appreciated the magnitude of the role at the beginning.

"It's a building everybody cares about. Everybody feels part of its family." ●

FAMILY TIES

With a father who was a Qantas aeronautical engineer for five decades, Ziggy Napier enjoyed plentiful exposure to engineering while growing up.

One of her brothers followed in their father's footsteps, becoming an aeronautical engineer; but rather than working on aircraft, he now works in them, having retrained as a pilot.

Another is a network engineer, who started his own internet service provider. Even Napier's uncle is in the profession, working as an industrial engineer.

"The upshot of all of this is that I knew what engineers did, and you tend to be attracted to what is familiar to you," she said.

"I grew up with all these great examples of different types of engineers and saw the flexibility and the different avenues that can be opened up by an engineering degree. It was really a matter of familiarity and thinking [that] it was up my alley."

This familiarity with engineering is less pronounced today — among schools, students, teachers and careers counsellors. In fact, most adults are not clear on what engineering entails, which speaks to the importance of STEM programs in schools, and other similar initiatives.

MEMBERS HAVE FREE ONLINE ACCESS TO ENGINEERS AUSTRALIA'S SEVEN TECHNICAL JOURNALS AT:
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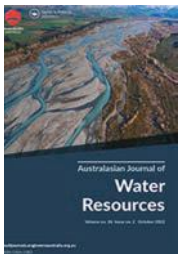
STAY CURRENT

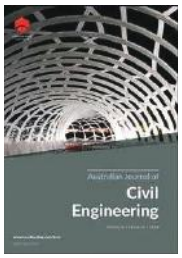
HIGHLIGHTS FROM AUSTRALIA'S MOST UP-TO-DATE ENGINEERING RESEARCH



DRAMATURGIES FOR RE-IMAGINING MURRAY-DARLING BASIN GOVERNING

Journal: *Australasian Journal of Water Resources*
Authors: R.L. Ison, N. Rubenstein, M.R. Shelton & P.J. Wallis

Effective governing of the Murray–Darling Basin along an unfolding, viable trajectory within an Anthropocene world seems more elusive than ever. This paper shows how a dramaturgical framework can be used to analyse a policy process to reveal the important symbolic and performative dimensions, which are usually unrecognised.



EXPERIMENTAL STUDY ON EVALUATING THE LATERAL LOAD CAPACITY OF RAKER PILE IN SLOPING GROUND

Journal: *Australian Journal of Civil Engineering*
Authors: S.K. Kayalvizhi, K. Muthukkumaran & S.K. Shukla

This paper describes results of static lateral load tests conducted on a single aluminium model raker pile embedded in loose sandy soil on 1V: 2H sloping ground. The loading directions were varied considering either forward or reverse loading for all pile positions. It was evident that in the case of the level ground and sloping ground with forward loading, the negative raker piles offer more resistance to lateral loads than vertical piles.

PERFORMANCE ANALYSIS OF QUADRUPED ROBOT DESIGNED WITH DESAI'S WALKING LEG MECHANISM

Journal: *Australian Journal of Mechanical Engineering*
Author: Kousik S, R. Suresh, A.R Annigeri, Praveen Kumar U.B. & Bharath M.N.

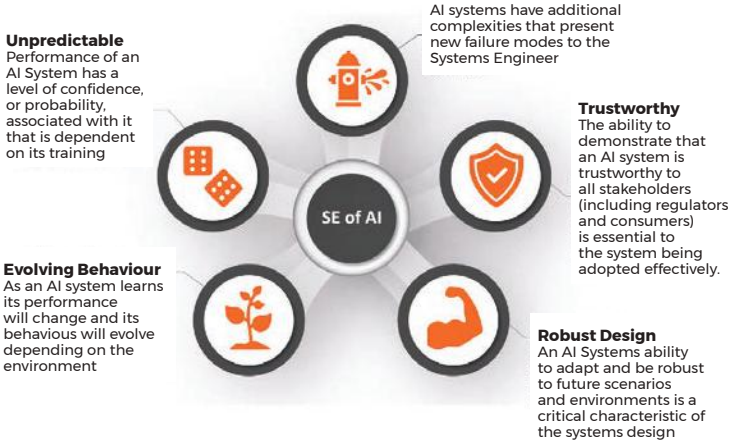
This paper describes simulation studies performed on a walking quadruped robot using an eight-link coplanar Desai's walking leg mechanism. The optimised link lengths of each leg in the quadruped robot are obtained based on motion along a straight path and a staircase.

The challenges for artificial intelligence and systems engineering

Journal: *Australian Journal of Multi-Disciplinary Engineering*
Authors: J. Vanderlinde, K. Robinson & B. Mashford

When engineering any system, it is important to ensure that the user of the system can be confident that the behaviour and performance of that system operates as needed. This paper considers the unpredictable and evolving behaviour of artificial intelligence (AI) systems and the inability to explicitly validate the level of trust in the systems and their robustness to future environments. It then looks at potential solutions to address this need and assist in the assurance of the performance of AI-enabled systems throughout their life cycle.

BELOW RIGHT:
Key challenges of artificl intelligence in systems engineering.



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Senior Civil Designer (MWH)

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CONFERENCE ON RAILWAY EXCELLENCE 2023 (CORE)

Location: in-person *Melbourne*
Website: *core2023.org*
The premier technical conference in Australasia's rail industry calendar is celebrating 25 years in motion. This year will highlight the technological and industry developments that are increasing and enhancing the effectiveness of rail.
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15-18 AUG 2023
AUSTRALASIAN COASTS AND PORTS

Location: in-person *Sunshine Coast*
Website: *coastsandports2023.com.au*
"Working together: 50 years of coasts and ports" is the conference theme for 2023. The conference will bring together professionals to focus on the technological, scientific, policy, planning and design issues related to our diverse and developing coasts.
Register now

07-08 SEP 2023
RISK ENGINEERING CONFERENCE 2023 (RISK 2023)

Location: in-person *Brisbane*
Website: *engineersaustralia.org.au/risk2023*
The conference theme for the 10th International Risk Engineering conference is "Risk engineering for a resilient 2030". It will bring together a wide range of engineering professionals and disciplines practising engineering-related risk management, risk analysis and risk-based decision-making processes when undertaking engineering activities.
Register now

11-13 OCT 2023
SEVENTH WORLD ENGINEERS CONVENTION

Location: in-person *Prague, Czech Republic*
Website: *wec2023.com*
This international event will bring together engineers, scientists, technical specialists as well as industry executives, policymakers, educators and students to exchange views and mobilise their crucial role in contributing to solving the most critical global problems of humanity.
Submit abstracts by 15 May 2023
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07-09 NOV 2023
IMC INTERNATIONAL MARITIME CONFERENCE

Location: in-person *Sydney*
Website: *indopacificexpo.com.au*
IMC International Maritime Conference invites delegates to be involved in discussions concerning the latest developments in naval architecture, marine engineering and maritime technology; both in the areas of defence and commercial shipping.
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29-30 NOV 2023

Climate Smart Engineering Conference 2023

Location: in-person Melbourne
Website: *engineersaustralia.org.au/cse*

Now in its third iteration, CSE23 will return in-person with a full technical and plenary program. Abstract submissions must close this month. Don't miss your chance to inspire the profession to be at the forefront of achieving net-zero emissions.

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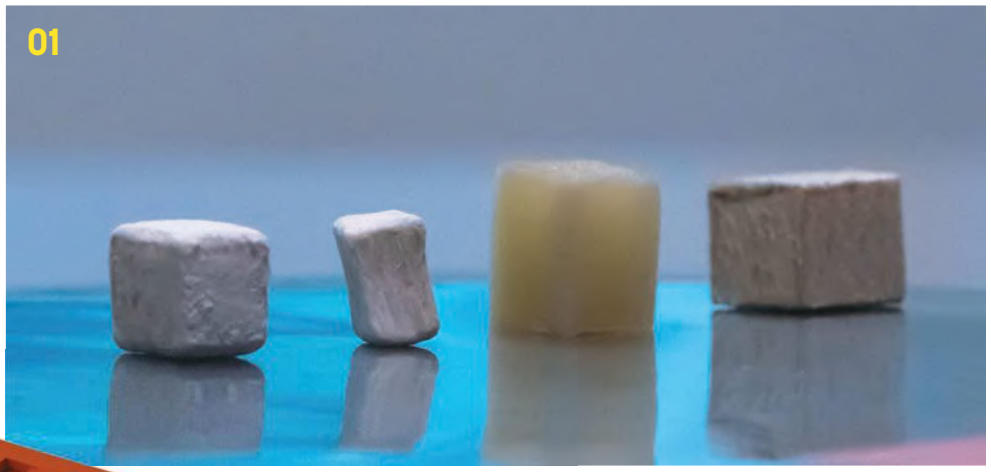
THE LATEST DEVELOPMENTS FROM AROUND THE WORLD.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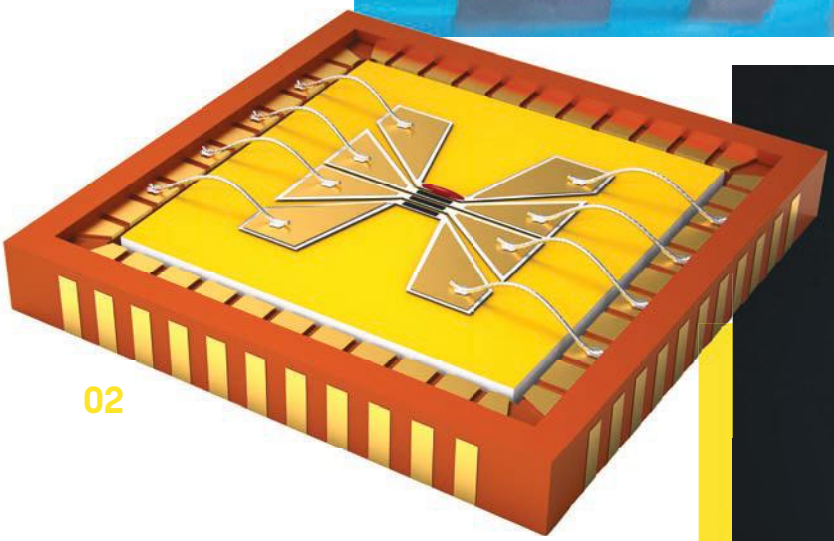
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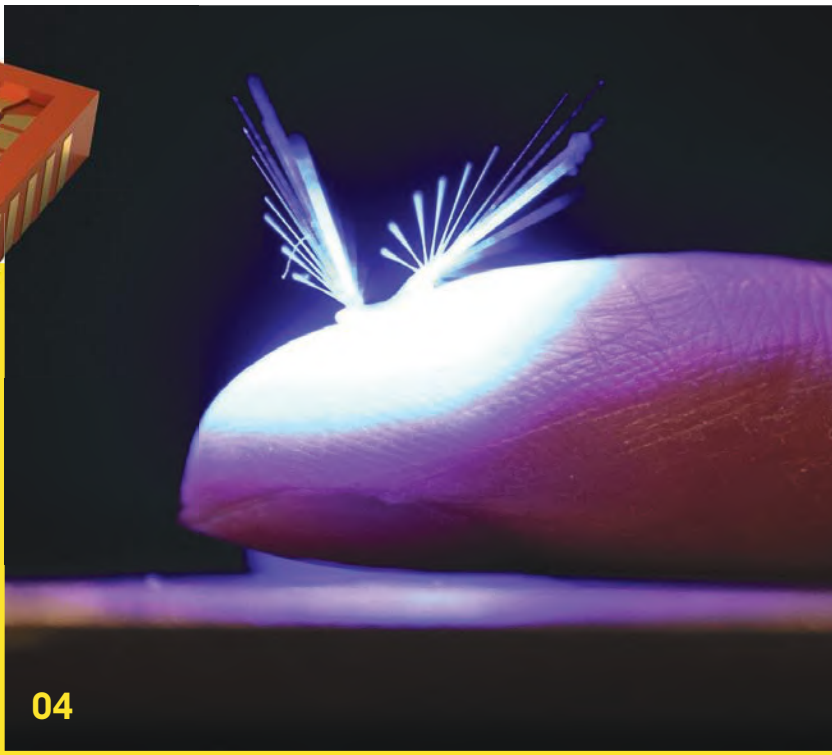
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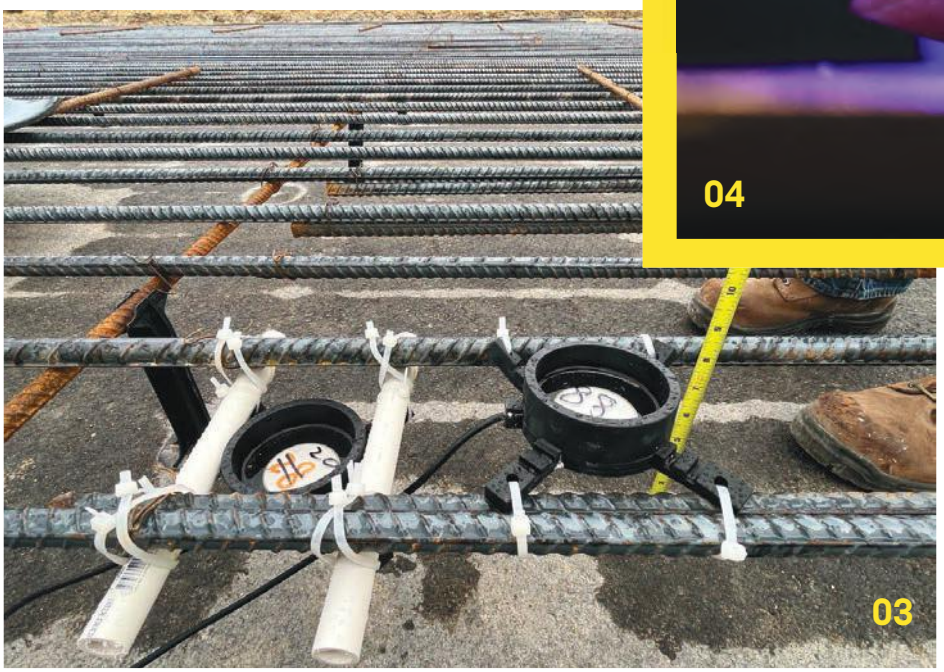
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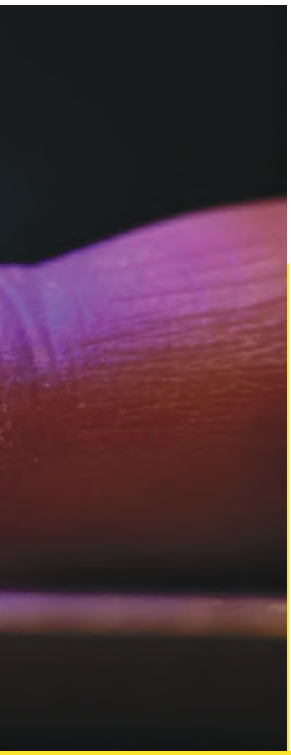
01

Carbon-trapping wood

Natural wood (left) and delignified wood, ready to be treated. Image: Gustavo Raskosky/Rice University



Researchers at the US's Rice University have engineered a new variety of wood that can trap carbon dioxide thanks to the addition of a crystalline porous material. By delignifying the wood — removing the cellulose fibres that give the wood strength and colour — and soaking it in a solution containing microparticles in a metal-organic framework (MOF), the material becomes a platform to adsorb carbon dioxide particles. "Our MOF-enhanced wood is an adaptable support platform for deploying sorbent in different carbon dioxide applications," said Rice University's Muhammad Rahman. "Removing the lignin is a fairly simple process that involves a two-step chemical treatment using environmentally benign substances. After removing the lignin, we use bleach or hydrogen peroxide to remove the hemicellulose." While not all MOFs are not suitable to be used in construction, Rice University's delignified wood performs better under a variety of environmental conditions than alternative materials.

02

Super-flat metasurfaces

Metasurface cells are more power-efficient and offer greater resolution. Image: Andrey Miroshnichenko/UNSW Canberra

A collaboration between the University of New South Wales (UNSW) Canberra, the Australian National University and the UK's Nottingham Trent University has produced a super-flat metamaterial that is 100 times thinner than liquid crystal display (LCD) cells. Providing greater resolution and using less energy, the metamaterial does not require the polarisers used in an LCD screen, which waste light intensity. Replacing the liquid crystal layer in a screen, the cells are tuneable and have light-scattering properties. "Our pixels are made of silicon, which offers a long lifespan in contrast with organic materials required for other existing alternatives," said Professor Andrey Miroshnichenko. "We hope this development could generate a frontier technology in new flat screen displays, which had a global market value of about $117 billion in 2020." The team's next step is to build a large-scale prototype, with the goal of having the metamaterial incorporated into consumer technology in 10 years.

03

Concrete sensor

Concrete sensors are trialled in the framework of a highway in Texas. Image: Luna Lu

A sensor embedded directly in concrete devised at the US's Purdue University promises to give engineers on road maintenance projects more precise and consistent data about the material with which they're working. The sensors communicate to a smartphone app and can be installed by placing them into a framework when concrete is being poured. "Traffic jams caused by infrastructure repairs have wasted four billion hours and three billion gallons of gas on a yearly basis. This is primarily due to insufficient knowledge and understanding of concrete's strength levels," said Professor Luna Lu of Purdue's Lyles School of Civil Engineering. "For instance, we don't know when concrete will reach the right strength needed to accommodate traffic loads just after construction. The concrete may go through premature failure, leading to frequent repairing." The technology, which saves engineers from having to take samples of materials to test them, is being trialled on interstate roads in nine US states.

04

Fairy robot

The light-controlled "fairy" robot is carried by the wind and could be used for pollination. Image: Light Robots Group, Tampere University

A project at Finland's Tampere University has led to the creation of a tiny flying robot powered by wind that researchers hope could be used for artificial pollination. Named the "Fairy", the device is controlled by light — such as a laser or LED — and weighs just 1.2 mg, allowing it to float in the air while being stabilised by separated vortex ring generation. In the dark, the device remains still, but it is activated when there is sufficient light. "Superior to its natural counterparts, this artificial seed is equipped with a soft actuator," said Academy Research Fellow Hao Zeng. "The actuator is made of light-responsive liquid crystalline elastomer, which induces opening or closing actions of the bristles upon visible light excitation." The next step is to scale the structure up so that it can carry biochemical compounds and electronic devices, with the hope that they could one day be deployed in mass quantities to assist in agriculture.

Kirsty Bateman

CPEng, Engineering Executive
Babcock Australia and New Zealand

ENGINEERING IN THE DEFENCE SECTOR REQUIRES UNDERSTANDING COMPLEX SYSTEMS HOLISTICALLY. FOR KIRSTY BATEMAN, IT'S A MINDSET THAT COMES NATURALLY.

KIRSTY BATEMAN began her career interested in prosthetic devices and studying electrical engineering, but her mind's ability to grasp complex systems quickly drew her into bigger picture spaces.

Able to grasp the ins and outs of real-time critical software systems, she moved into air traffic control and then, before she had realised that it was a field, systems engineering.

"I stayed there most of my career, and got a bit of project management, a bit of leadership, a bit of corporate work," she tells *create*. "That's what I really enjoy as well — trying to work out how it all fits together and how they all interact."

It has been the intricate systems of the defence industry that have allowed Bateman to make the most of this talent, and her career has taken her to such leading companies as Thales Australia, BAE Systems and, now, Babcock Australasia.

She has maintained a consistent approach across the variety of projects on which she has worked and recalls one manager telling her that she wasn't engaged to be a hardware expert: "I'm employing you for your systems knowledge and the way that you think and to put things together."

"It was more about learning about the program details, learning about the challenges, understanding from the experts," Bateman said.

"It was more about how I approach the program with systems thinking."

Having worked on a variety of programs, Bateman's position at Babcock comes with new fields.

"These different programs are exciting because I've never worked in some of these areas," she said.

"As a chief engineer you are overseeing those programs, making sure that we can deliver the capability on time and on budget."

Bateman also highlights her passion for helping develop the people who work for her — and part of that is advocating for Chartership.

"The Chartership process allows you to hit all the different fields that are required to be a practicing engineer, whether it's ethics or it's your actual practise of study," she said.

"It makes sure that you have the whole complete picture of what an engineer has to be to get Chartered and therefore allows you to then start building your career on to making more decisions and taking on more responsibility and accountability."

And she sees Chartership as valuable information for employers and employees.

"When you're looking at people's CVs, and you see they're Chartered, you know know they have been independently assessed and have achieved this status," she said. ●

03 TIPS FOR SUCCESS

1 Take opportunities when they present themselves, even if you're not sure you want to explore them.

2 Don't be afraid to ask for help when you need it.

3 Use all the resources available to you – sometimes it isn't engineering that will solve a problem.

IMAGE: DAMIEN PLEMING

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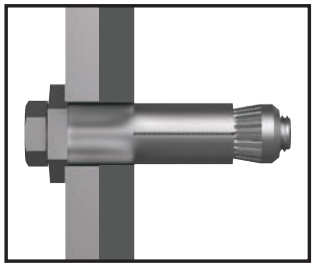

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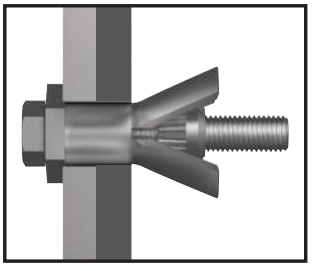

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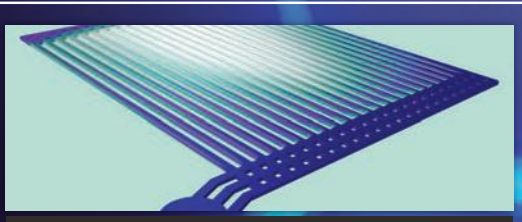

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