VOL. 8 | NO. 10 | NOVEMBER-DECEMBER 2022

create

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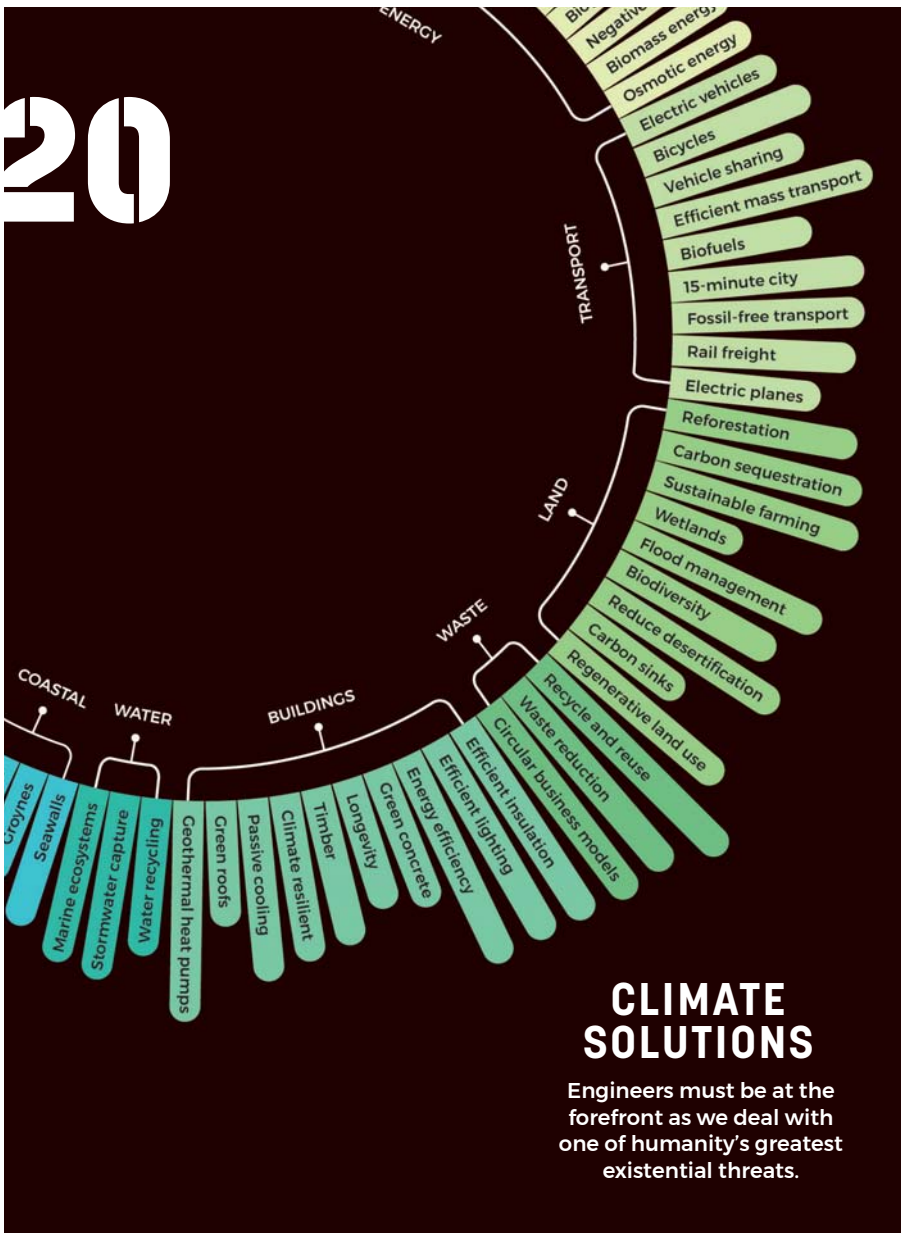

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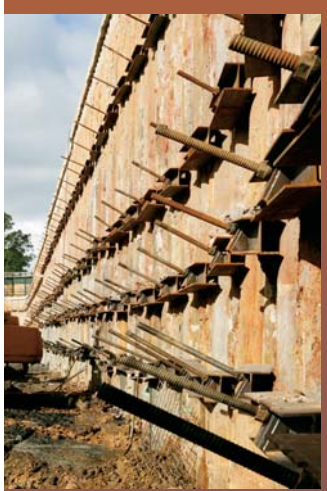

Top Reasons to Attend

- Network with deep foundations practitioners from around the world
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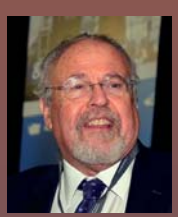
Keynote Speakers

"The Geotechnical Industry's Role in Sustainable Development"
Kimberly Martin, Ph.D., P.E., ENV SP, Keller

"Forms of Contracting, Approaches to Risk Sharing and the Impact on Innovation, Productivity and Project Outcomes"
Phil Oxley, Mott MacDonald

"The Application of Dynamic Analyses for Testing of Non-Uniform Deep Foundations"
Samuel Paikowsky, Ph.D., Professor, University of Massachusetts Lowell



"Driven Displacement Pile Ground Improvement for Liquefaction Mitigation"
Armin Stuedlein, Ph.D., P.E., Associate Professor, Geotechnical Engineering, Oregon State University

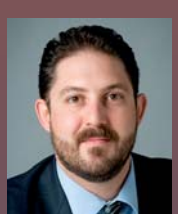
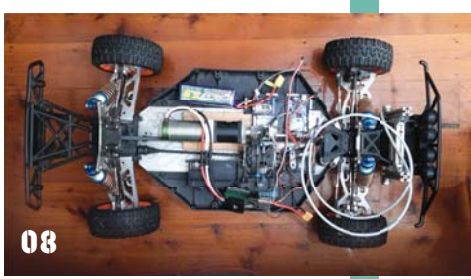


IMAGE: AIRSEED TECHNOLOGIES

EVERY ISSUE



NEWS

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Check out the *create* website — your best resource for the latest engineering news and information from Australia and the world.

Working for community good

THE RECENT EXCELLENCE AWARDS SHONE THE SPOTLIGHT ON THE MANY ENGINEERS INNOVATING AND DRIVING CHANGE TO ADVANCE SOCIETY.

Welcome to the final issue of *create* for 2022. This month we see our Climate Smart Engineering Conference back for a second year, where the profession's top minds will come together to present and debate solutions to climate change in all its facets. Last year's conference was a resounding success, and this year looks to build on that platform.

It is our pleasure to detail for readers the winners of the recent Engineers Australia Excellence Awards. It was a gruelling task for the judges to narrow down recipients from such a stellar field.

We are in a period of great change, when the ethical stewardship of engineers will take us forward into a transition to clean energy and a sustainable future. The pace of technological advance is marching on, and engineers are at its beating heart.

Engineering is a profession known for its precision, commitment and drive. For many, it is the passion of a lifetime, whether that manifests as designing, inventing and innovating, researching, advocating and teaching, or developing, directing and managing.

These pursuits are all crucial parts of engineering, and they are what combine to fulfil our mission of advancing society through great engineering.

Our Excellence Awards winners and finalists have this in common; an outstanding capacity to lead by example and work for the good of the community and the planet. They give us a forum to shine the spotlight on the best of engineering, setting standards of excellence and leadership for the profession and blazing a trail for the future of the field.

We need our engineering leaders now more than ever to encourage more children into STEM and support graduates through their early years in the industry.

We are facing many challenges, through climate change and the pandemic to global unrest and poverty. It is an era that will test the mettle of engineering and demonstrate why the profession deserves a seat at the table. For this, we appreciate the opportunity to recognise those among us whose hard work and dedication over many years sets them apart in a high-achieving cohort. It is such stewardship that assures the future of engineering and sets our trajectory to tackle the challenges we face.

As 2022 winds down, we wish you a safe and happy holiday period.

"We appreciate the opportunity to recognise those among us whose hard work and dedication over many years sets them apart in a high-achieving cohort."

Dr Nick Fleming
FIEAust CPEng EngExec NER
APEC Engineer IntPE(Aus) GAICD,
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Romilly Madew AO
FTSE HonFIEAust,
Chief Executive Officer
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Safe crossing

RATHER THAN MONITOR ROAD STRUCTURES THROUGH NETWORKS OF PERMANENTLY INSTALLED SENSORS, THIS ENGINEER HAS DEVISED A MORE MOBILE SOLUTION TO BRIDGE SAFETY.

ALTHOUGH THEY occasionally make headlines for the wrong reasons, bridges are inherently safe structures. The chances of a fatality from a collapse anywhere in the world each year are one in 100 million.

Dr Mehrisadat Makki Alamdari, Senior Lecturer with the School of Civil and Environmental Engineering, UNSW Sydney, has adopted a novel technique to analyse bridge safety. Her approach deploys a small sensor-packed car that drives over the bridge collecting key information on the structure's characteristics and health.

Interestingly, it wasn't civil engineering study that led Alamdari to work on bridges. "My background is in aerospace engineering, and we had a lot of courses related to vibration and structural dynamics," she says. "If you consider the structure of an aeroplane, it is continuously under dynamic vibration."

After completing her PhD on vibration with structural health analysis, Alamdari moved to CSIRO and started work monitoring the Sydney Harbour Bridge.

"My role was to provide domain knowledge about signal processing and vibration characteristics of this bridge," she says. "Under the bus lane of the Sydney Harbour Bridge, there are more than a thousand accelerometers that collect the vibration response of the bridge as soon as a vehicle passes over and triggers the sensor."

CSIRO collects these vibration responses in real time and uses machine-learning-based algorithms to analyse them. Any significant change in the vibration response can be an indication of something wrong with the bridge.

Alamdari's work attracted the attention of road authorities, especially in regional areas, which face particular challenges.

"Some overloaded trucks make detours over these regional bridges to avoid weighing stations on more direct routes. This can cause significant damage to bridges in rural areas that aren't built to take these loads," she says.

Regular inspections and maintenance of bridges is key to their longevity.

"Implementing and deploying a structural health monitoring system like we have on the Sydney Harbour Bridge is a very costly exercise," she says. "Add to that the maintenance of the system, the transmission of data,

"IT REALLY DOESN'T MAKE COMMERCIAL SENSE TO APPLY A COMPLEX SOLUTION TO A LARGE NUMBER OF SMALL BRIDGES."

ABOVE RIGHT: Dr Mehrisadat Makki Alamdari.

Coates

ENGINEERING SOLUTIONS

World's lightest, heavy-duty structural support for temporary works unveiled

A world-first innovation, the result of a collaboration between Coates and Monash University, will improve performance, safety, cost and sustainability of propping systems.

When permission to temporarily anchor concrete piles beneath a neighbouring property was denied during a basement excavation on a long and narrow residential site in Perth, contractor Belpile turned to Coates to design and install an internal shoring system.

"The large hydraulic props were heavy and difficult to install with a large mobile crane due to access issues," says Julia Li, Senior Project Engineer at Belpile. "When I was told that an alternative design method is on the way, one that is much lighter, easier to transport and install, and has a higher load carrying capacity, it struck me as a solution that would likely have economic and safety benefits."

The future of temporary works

Quadshore, the result of a research agreement between Coates and Monash University, is the world's lightest, heavy-duty structural support system for temporary works.

Quadshore 150's working load limit (WLL) is up to 170 tonnes and its WLL to weight ratio is at least 1.7 times higher than conventional propping systems. The medium-duty Quadshore 50's working load limit (WLL) is up to 60 tonnes and its WLL to weight ratio is at least 1.4 times higher than conventional propping systems.

"As a significantly lighter propping system, Quadshore is able to enter narrower construction sites requiring tighter maneuvering," Associate Professor Amin Heidarpour FIEAust CPEng, Head of Monash Structural Engineering, says. "A higher working load limit to weight ratio also reduces the number of workers needed on a site.

"In addition, transporting construction elements from the yard to the site and vice versa contributes to the carbon emission and costs of each project. When we reduce the weight, we significantly reduce the carbon emission associated with the manufacturing and transportation."

Safer and more cost-effective

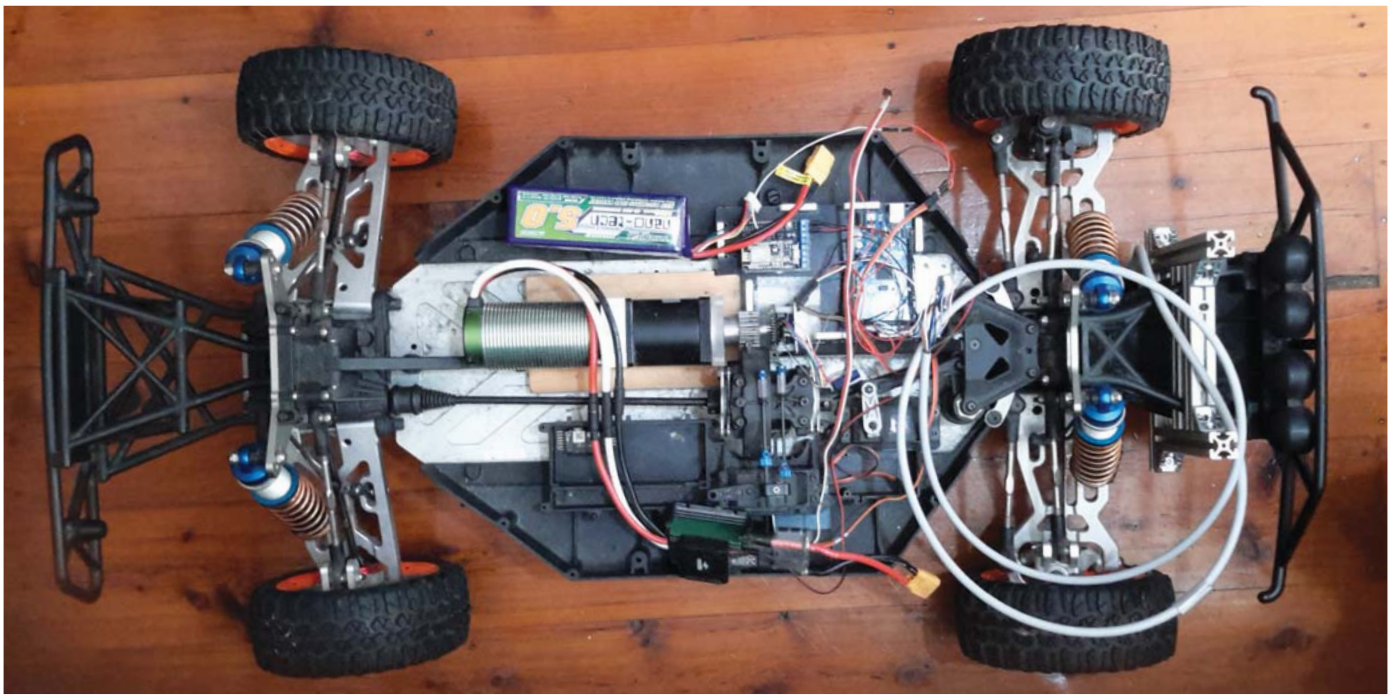
A Coates and Monash white paper revealed 38 per cent of infrastructure incidents are related to the construction phase where temporary works are utilised. It's an issue they sought to address with the development of Quadshore, which doesn't require any bolts to assemble the modules.

This means lifting, repetitive tightening and awkward maneuvering is not required, while assembly and disassembly is at least 40 per cent faster than conventional systems.

"We did a bridge project a little while ago for Sydney Metro," says Sudhir Raina CPEng, Engineering Product Manager at Coates. "If this product had been available then, it would have taken half the time and required zero consumables. The Quadshore solution has real, tangible benefits."

Scan to download the Quadshore white paper.

Quadshore 150 selected components.



the need to provide power in a very remote area, and WiFi for data transmission."

Alamdari says that for a small bridge with a span of 50 m, it would cost about $200,000 to install a comprehensive sensing system, but a local council may only have an annual budget a tenth of this for each bridge.

"It really doesn't make commercial sense to apply a complex solution to a large number of bridges. And the problem we are facing in Australia is that many of these deteriorating, shorter-span bridges are in regional areas."

Alamdari is drawing on her expertise in structural health monitoring and vibrational analysis to develop a new mobile technology that strikes a balance between efficiency and economy.

Rather than loading up a bridge with expensive sensors, what if you were to put sensors on vehicles that measure the state of the bridge as they pass over it?

This idea was first floated more than a decade ago, but nobody has demonstrated it in the real world. Alamdari and her research group are getting closer to seeing this become a reality.

"THE CAR WILL MOVE BACK AND FORTH MANY TIMES TO COLLECT A RICH DATASET OF THE BRIDGE'S HEALTH."

"My DECRA [Discovery Early Career Researcher Award] brief is to come up with advanced signal processing techniques to extract the vibration response of a moving vehicle and then build a data-driven algorithm using machine learning and artificial intelligence to compile a database about key indicators of the bridge's structural health," she says.

Her team, in collaboration with partners at Japan's Kyoto University, will investigate several short-span bridges to test a small prototype inspection vehicle.

"The next step is to gradually introduce artificial damage into the structure of the bridge and verify that our signals reveal this damage, purely by processing the response of the vehicle."

The custom-built vehicle that Alamdari's team uses to carry out its testing looks a bit like a miniature Formula One car. The autonomous electric car has a length of about one metre, weighs approximately 30 kg and can also be controlled remotely.

"We have equipped this car with vibration sensors, displacement sensors, load cells, accelerometers," says Alamdari.

A battery-powered data acquisition system attached to the top of the car collects data in real-time when the car moves over the bridge.

The accelerometers and load cells measure the dynamic response of the vehicle as it moves over the bridge as well as measuring the interaction force between the vehicle and the bridge. It can reach a speed of 10 m/s, but the vehicle speed is best kept at a lower speed.

"The car will move back and forth many times to collect a rich dataset of the bridge," says Alamdari. Once data is collected, it will be analysed offline to see if there are any anomalies compared to the benchmark state.

"We aim to examine the structure of the bridge cost effectively and more frequently, to identify any major damage before it has catastrophic consequences," says Alamdari.

KEVIN GOMEZ

ABOVE: The test car is equipped with sensors and accelerometers.

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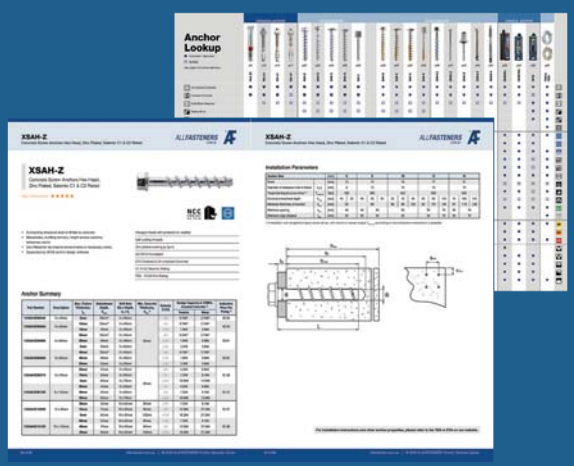

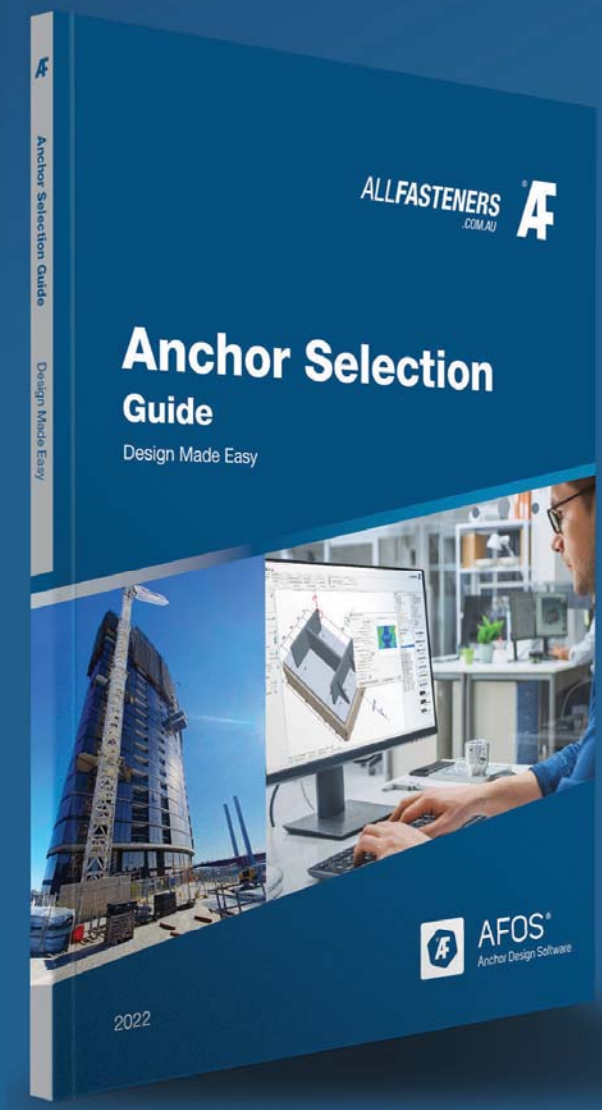

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FROM YOUNG ENGINEERS BURNING BRIGHT WITH ENTHUSIASM TO THOSE STILL INNOVATING FROM SEMI-RETIREMENT, THE STIRRING SCOPE AND AMBITION OF AUSTRALIA'S ENGINEERING COMMUNITY WAS ON FULL DISPLAY AT ENGINEERS AUSTRALIA'S EXCELLENCE AWARDS LAST MONTH.

PICTURED: The UniWave200 Wave Energy Converter won this year's Sir William Hudson Award.

THE PROFESSION'S finest gathered at the annual Engineers Australia Excellence Awards gala dinner to celebrate the inspired minds whose achievements highlight the innovation driving engineering forward.

Though their work spans a remarkable number of fields and approaches, the winners were united by a passion for raising the profile of the contribution engineers make.

WORDS BY **CHLOE HAVA**

BEST & BRIGHTEST

Peter Nicol Russell Career Achievement Memorial Medal

Peter Cockbain

Engineers Australia's most illustrious individual accolade, the Peter Nicol Russell Career Achievement Memorial Medal, was awarded to longtime leader Peter Cockbain AM HonFIEAust in recognition of his lifelong dedication to the field of engineering and the broader community.

With a career spanning five decades, Cockbain is a founder of electrical manufacturing company Ampcontrol, and has been a passionate member of Engineers Australia for more than 50 years, including a stint as National President.

Cockbain was also appointed a Member of the Order of Australia (AM) in 2015 for his service in the field of electrical engineering, and awarded the University of Newcastle Alumni Medal for Professional Excellence in 2021.

Despite the many awards and recognitions Cockbain has received, one of his proudest achievements was attaining his engineering qualifications while raising a young family.

"I started as an apprentice electrician when I was 15. I went to university when I was 26, during which time my wife and I had our three children," he says. "I studied for six years, four nights per week, three hours per night."

But Cockbain says he is also proud of Ampcontrol, the company he co-founded in 1966, and how far it has come – a success he puts down to the collaborative stance the company took from day one.

"I have only ever been a willing participant in very talented teams," he says. "Collectively, we've achieved a lot. Our company logo is: 'I can't do it. You can't do it. But we can'. It's always been about what we could achieve together, not the individual achievement of one person."

"IT'S ALWAYS BEEN ABOUT WHAT WE COULD ACHIEVE TOGETHER, NOT THE INDIVIDUAL ACHIEVEMENT OF ONE PERSON."

ABOVE: Peter Cockbain (centre) with Engineers Australia National President Nick Fleming (left) and CEO Romilly Madew.

Young Professional Engineer of the Year

Deanna Hood

Robotics engineer Deanna Hood has been named the 2022 Young Professional Engineer of the Year in recognition of her impressive work and dedication to leveraging engineering know-how in pursuit of changing the world for the better.

A tireless ambassador for altruistic engineering, Hood has worked on a variety of technological marvels, including: a mind-controlled car for people with paralysis; a 3D-bioprinter enabling cancer researchers to print living replica-tumours; and a low-cost USB stethoscope for diagnosing childhood pneumonia.

Just 13 years since she entered the world of engineering, Hood's most recent endeavour was as one of two founding engineers on Ligō – a skin-printing robot that allows faster and improved skin regeneration of large-area burns.

"I still find myself in shock at the engineering career that I've created for myself, given that I had never even heard of engineering when I finished high school. I feel so lucky to have stumbled upon this career, because I enjoy it so much," she says.

"I FEEL SO LUCKY TO HAVE STUMBLED UPON THIS CAREER, BECAUSE I ENJOY IT SO MUCH."

Hood says the type of technology she will be working on in her future career is likely yet to be foreseen – which is what she loves about engineering. ▶

RIGHT: Deanna Hood receives the Young Professional Engineer of the Year Award from Madew (left) and Fleming.

Professional Engineer of the Year

Karu Esselle

UTS Professor Karu Esselle FIEAust has taken out the 2022 Professional Engineer of the Year award for his leadership in advancing human connection and capability through engineering, with many of his technologies focusing on social and economic sustainability. He is an internationally renowned researcher in electromagnetic and antenna engineering.

His current work includes a soon-to-be-announced project with the potential to provide low-power, low-cost, high-throughput internet access from anywhere in the world and advancing the control of implanted medical devices.

Esselle says he is humbled by the award and dedicated the honour to his associates, collaborators and students.

RIGHT: Karu Esselle receives the Professional Engineer of the Year Award.

"MENTORING THE NEXT GENERATION OF ENGINEERS AND SCIENTISTS HAS BEEN MY PASSION FOR DECADES AND IT WILL CONTINUE."

"Mentoring the next generation of engineers and scientists has been my passion for decades and it will continue," he says.

His next step is to help Australia become a global leader in engineering technology by developing innovative, world-leading products that are designed, developed and hopefully, manufactured by Australians for domestic and global markets.

HONORARY FELLOWS

- Professor Hui Tong Chua
- Dr Ernest Evans
- Professor Keith Hampson
- David McHugh
- Professor Doreen Thomas AM
- Merryn York
- Prof Xinghuo Yu

RIGHT: Malcolm Shepherd receives the Engineering Associate of the Year Award.

Engineering Associate of the Year

Malcolm Shepherd

WaterAid Australia Director Malcolm Shepherd FIEAust CEngA took out the Engineering Associate of the Year title following his contribution to engineering and society via community well-being projects within the water space.

"I've had lots of memorable moments in my career, but being recognised by peers with an award such as this is an unforgettable moment," he says.

Shepherd says giving back to the profession that has given him so much pleasure is particularly important to him.

"The ability to influence the strategic direction of engineering in the water sector to deliver the benefits and outcomes through reframing the way that people think about problems in the water sector I have found personally rewarding," he says.

"I am particularly proud of my contribution regarding gender, equality, social inclusion, and disability through WASH [water and sanitation and health] programs in emerging economies which can, ultimately, contribute to the health of women and children. Healthy children become healthy adults and healthy adults can make a difference in changing the cycle of poverty."

"I AM PARTICULARLY PROUD OF MY CONTRIBUTION REGARDING GENDER, EQUALITY, SOCIAL INCLUSION, AND DISABILITY THROUGH 'WASH' PROGRAMS IN EMERGING ECONOMIES."

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*Based on 2021 quantitative research of members and non-members of Engineers Australia.

LEFT: Nicholas Clarke receives the Engineering Technologist of the Year Award.

Technologist of the Year

Nicholas Clarke

Nicholas Clarke CEngT has been named the 2022 Engineering Technologist of the Year in acknowledgement of his contribution to and delivery of cutting-edge engineering solutions in a variety of sectors.

With a background in space, weapons and intelligence, Clarke served in the Australian Defence Force before working as an engineer delivering state-of-the-art technologies for defence and government agencies.

"I was absolutely flabbergasted to be named the Engineering Technologist of the Year by Engineers Australia. I'm at the tail-end of my career, but I still get a big buzz out of what I do," Clarke says. "Every day, I work towards finding new ways to use technology. My job is all about taking technology that is being used a certain way and altering it to create completely new applications."

"MY JOB IS ALL ABOUT TAKING TECHNOLOGY THAT IS BEING USED A CERTAIN WAY AND ALTERING IT TO CREATE COMPLETELY NEW APPLICATIONS."

Acknowledging his work is at the forefront of innovation, Clarke says he wants to see more people being inspired by the great work there is to do in the field.

"I believe we've got to get engineering back to being exciting," he says. ●

Sir William Hudson Award

UniWave200 Wave Energy Converter

The UniWave200 Wave Energy Converter has earned the prestigious Sir William Hudson Award — Australia's highest accolade for an engineering project.

The project, the first successful wave energy converter trial in the nation, received the award at the annual Engineers Australia Excellence Awards gala dinner.

The project is the work of Wave Swell that has developed proprietary technology to convert ocean waves into zero emission electricity.

The company's 200 kW demonstration project was launched last year, off the coast of King Island in Tasmania, and powers up to 200 homes for a year.

Wave Swell Chief Technology Officer Scott Hunter says he is delighted by the award, particularly as the firm moved forward from the demonstration project and into commercialisation efforts.

"The fact the award is from Engineers Australia will really help illustrate that we are a company to take seriously," says Hunter.

Wave Swell Chief Development Officer Tom Wilson says the award had the potential to accelerate their growth. The game-changing innovation at the heart of Wave Swell's success is a new take on the long-standing oscillating water column (OWC) approach.

Previous OWC-based technologies have used bidirectional turbines, whereas Wave Swell's turbine is unidirectional.

This elegant simplification creates not only a more robust and reliable design, it has also increased the energy conversion efficiency, to up to 48 per cent.

The unit's only moving parts — the turbine and valves — are above the waterline, greatly increasing durability, cutting maintenance costs and risks, and mitigating potential harm to marine life.

Hunter says the team is currently working on upscaling the technology to create a 1 MW unit.

A CSIRO analysis of the project found that the technology is already cost-competitive with diesel generation and would reach cost parity with offshore-wind generation once the global installed capacity reaches between 25 MW and 45 MW.

This would translate as a levelised cost of energy of just five cents per kWh. ●

RIGHT: The Wave Swell team receives the Sir William Hudson Award.

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Peter Thomson
Senior Civil Designer (MWH)

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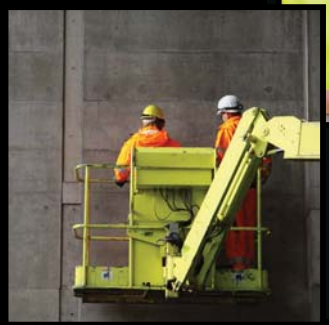

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CSE222 will be an in-person and online event held on 22-23 November 2022.

Register at eacse.com.au

CLIMATE LEADERSHIP

Dr Nick Fleming FIEAust CPEng
National President,
Engineers Australia

NOVEMBER IS an important month at Engineers Australia with our Climate Smart Engineering conference back for a second year, again demonstrating our commitment to climate leadership.

The conference brings together people from a range of engineering disciplines, industry sectors, and environmental and social governance backgrounds – all with the commonality of addressing climate change in its many manifestations.

The engineering profession is central to climate solutions, including through integrated infrastructure planning, advanced technology, skills and energy capacity to name just a few.

Our Climate Smart Engineering conference is about ideas and action. It's about making critically important connections and expanding our networks to serve as deeper conduits to great engineering outcomes and the opening up of doors of opportunity in our modern workplaces.

It's about respectfully learning from each other as an informed Engineers Australia climate community – whether you're a member or not; and also as a collective that cares about the profession being publicly regarded as innovative, responsible and solutions-focused.

Engineers Australia's Climate Change Position Statement observes that as engineers our perspectives are firmly grounded in science and risk management.

After almost 30 years of the Intergovernmental Panel on Climate Change assessment reports on the state of this global crisis, I hope our community of applied scientists increasingly feels that they possess the skills and influence to manage the uncertainties of climate impacts for all engineered systems and assets.

Climate change exposes our global community to one of the greatest existential threats it has ever faced and which we must collectively overcome.

But we can re-engineer this threat and turn it into a catalyst for opportunity. We can do this by striving for more circular economies that nurture the environment and that foster a safer, fairer and less polluting and wasteful existence, seeing nature as a valuable asset for a sustainable and prosperous economy.

Engineering is at the forefront of making this vision a reality. Engineering-led innovations such as blockchain, machine learning, satellite monitoring and measurement, mass communications, decentralised energy, and artificial intelligence (to name but a few) can help to create economic opportunity. They also shine a very bright global spotlight on our management of greenhouse gas emissions.

Indeed, wherever emissions are being released – from deforestation to industrial methane producing facilities – these engineering solutions can identify who is responsible and the scale of what needs to be done to make good.

And this gives me optimism for the future: knowing that our engineering competency and ingenuity continues to strive to make real-world differences in the challenges and opportunities presented by climate change.

I'd also like to note that our recent accreditations to the United Nations Framework Convention on Climate Change, the United Nations Environment Assembly, and the United Nations Environment Program, position Engineers Australia as an emerging global engineering voice of influence.

Closer to home – to all those attending our Climate Smart Engineering conference, thank you for not only being Engineers Australia's greatest champions on climate but for also being our greatest assets in helping to win the climate change battle. ➤

NICK FLEMING

"CLIMATE CHANGE EXPOSES OUR GLOBAL COMMUNITY TO ONE OF THE GREATEST EXISTENTIAL THREATS IT HAS EVER FACED AND WHICH WE MUST COLLECTIVELY OVERCOME."

REIMAGINING CARBON

Sophia Hamblin Wang

Chief Operating Officer, MCi Carbon

SOPHIA HAMBLIN WANG relishes a challenge, whether it be a Rubik's cube – her personal best competition time for a 3x3 solve is 34.21 seconds – or tackling climate change.

As Chief Operating Officer at MCi Carbon, Hamblin Wang and her team are working on transforming carbon emissions into building materials and other valuable products. They are thus empowering industries globally to decarbonise while enabling low-carbon embodied materials for a truly circular economy – all without the need for a price on carbon.

"MCi specialises in creating low emissions powders and outputs that combine CO_2 emissions from industry or from direct air capture, combining those emissions with industrial wastes or low-grade minerals to create outputs such as magnesium carbonate, calcium carbonate and silica," says Hamblin Wang.

For the past nine years, MCi has been processing these outputs into cement and plasterboard drywall products which are large, target markets for low carbon embodied materials.

"However, the magnesium carbonate and calcium carbonate products in particular have a very good, high quality, low emissions profile," Hamblin Wang says.

In 2013, MCi secured $9.12 million to design a pilot plant that would serve as a global reference point for the large-scale capture and storage of carbon dioxide via mineral carbonation.

Recently, the company received $14.6 million from the Australian Government to build a demonstration plant on Newcastle's Kooragang Island.

"WE COULD BE LOCKING AWAY 19 MILLION TONNES OF CO_2 WITHIN AUSTRALIA PER ANNUM."

ABOVE: MCi product prototypes, plasterboard and concrete: produced via mineral carbonation at the MCi Pilot Plant in Newcastle.

Currently, MCi's pilot plant processes a variety of feed stocks, including industrial waste like steel slag, incinerator bottom ash from cement kiln dust and mine tailings.

"We handle anything that contains a magnesium or a calcium component because they bind to the CO_2 to create the carbonate," says Hamblin Wang.

She acknowledges that there are numerous carbon dioxide removal solutions being developed and that each of these technologies will be applicable in different scenarios and should be implemented at the most suitable place.

MCi's technology is suited to decarbonising sectors that have the potential to abate but may not be able to achieve emissions reductions goals in the immediate term.

The process works best if it is near the carbon dioxide source and located close to a local market that can buy the products.

According to Hamblin Wang, the process needs approximately three to four tonnes of mineral feed stock or industrial waste to lock away one tonne of carbon dioxide. MCi's net revenue would fall somewhere between breaking even and making $350 per tonne of carbon dioxide, with a variety of different outputs.

"Obviously, it's highly context specific, which is why we don't have just one number there," says Hamblin Wang.

The solution to dealing with emissions reduction lies at the intersection of technology, policy and market forces, and the government has a critical role to play.

"I feel very passionate about this because the government's role is to set a path for technologies to grow and scale," says Hamblin Wang.

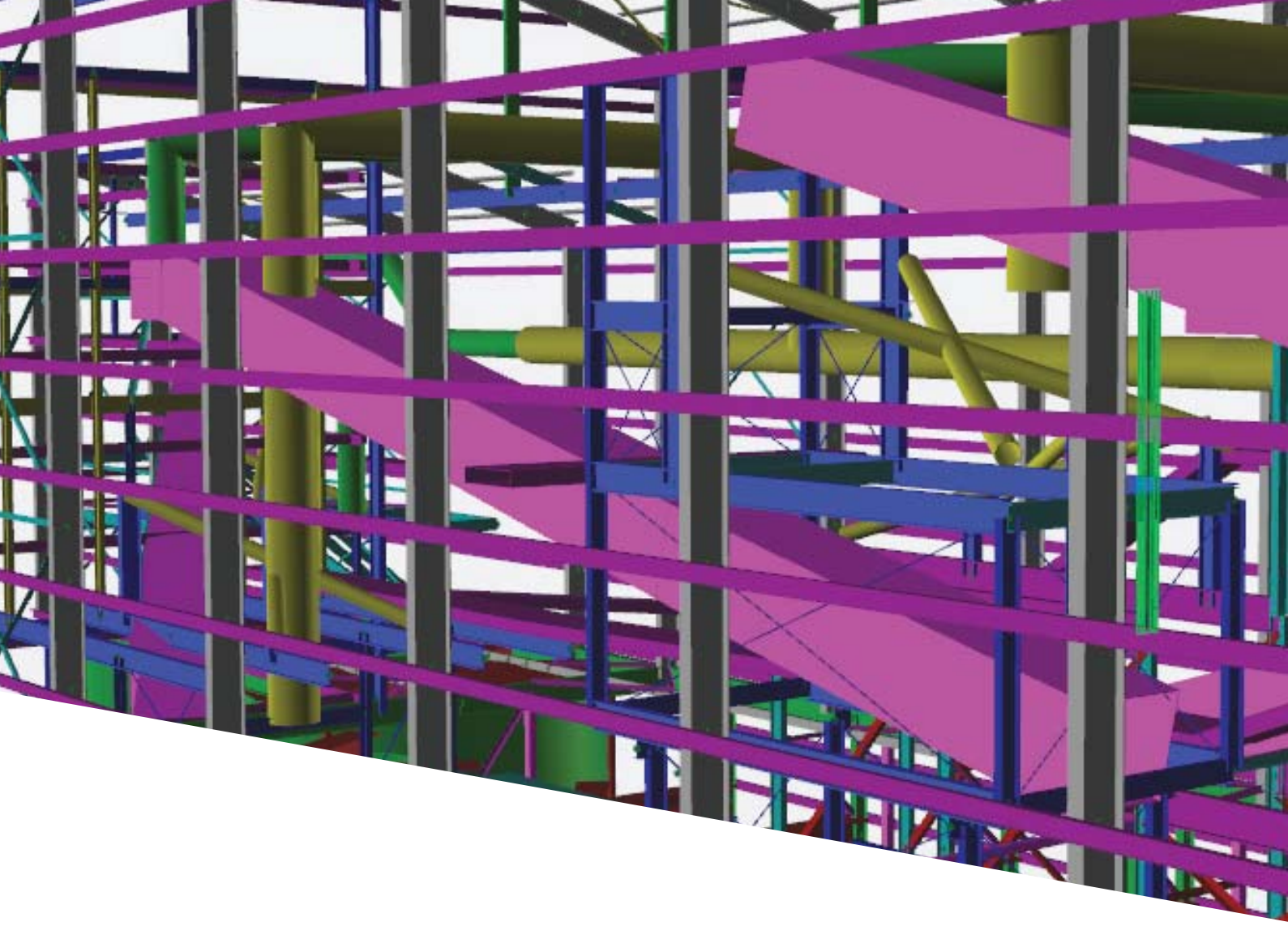
Last year, the Australian Government developed a CCS Emissions Reduction Fund methodology for the validation and granting of carbon credits for CCS. It is currently halfway through the development of a carbon capture and utilisation and storage methodology, which, in the future, will grant credits to technologies in the circular carbon economy.

"However, the process is unclear right now," says Hamblin Wang. "We need certainty around the policy and validation of the development of these methods because Australia granting carbon credits to carbon capture and utilisation really sets us apart from our global competitors, particularly around the future tradeability of the carbon credits in global markets."

Hamblin Wang also points to the CSIRO's CO_2 Utilisation Roadmap released last year.

"We could be locking away 19 million tonnes of CO_2 within Australia per annum if we accelerate at the opportunity," she says. "And we think that number is a low estimate, but it's still really good to have it out there." ▸

KEVIN GOMEZ



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CONCLUSIONS FROM THE IPCC 6TH ASSESSMENT REPORT

Kevin Hennessy
Lead Author of the Australasia Chapter, IPCC's 6th Assessment Report on Impacts, Adaptation and Vulnerability

THE INTERGOVERNMENTAL Panel on Climate Change (IPCC) provides governments with scientific information for use in climate policies and international climate change negotiations. Thousands of scientists from all over the world contribute to the IPCC.

They provide a summary of what is known about observed and future climate change, observed impacts and future risks, and how adaptation and emission reductions – mitigation – can reduce those risks.

Three IPCC reports have been published within the past year: *The Physical Science Basis of Climate Change*, *Climate Change Impacts, Adaptation and Vulnerability* and *Mitigation of Climate Change*.

Increases in greenhouse gases since 1850, caused by human activities, have warmed the atmosphere, ocean and land.

The surface has warmed by 1.1 degrees Celsius on average, with the greatest increases over land and near the poles.

Global-average sea level has risen. Glaciers and Arctic sea ice have retreated. Many weather and climate extremes are being affected, including heatwaves, heavy rainfall, droughts and tropical cyclones.

Ongoing increases in greenhouse gases will lead to global warming of 1.5 degrees Celsius by around 2030 and 1.6 to 2.4 degrees Celsius by around 2050. A low emissions pathway could limit the warming to 1.8 degrees Celsius by 2090, while a high emissions pathway could cause warming of 4.4 degrees Celsius by 2090.

CHANGES IN RAINFALL

Further increases are expected for sea level, extremely high temperatures, marine heatwaves, heavy rainfall and droughts, with reductions in Arctic sea ice, snow cover and permafrost.

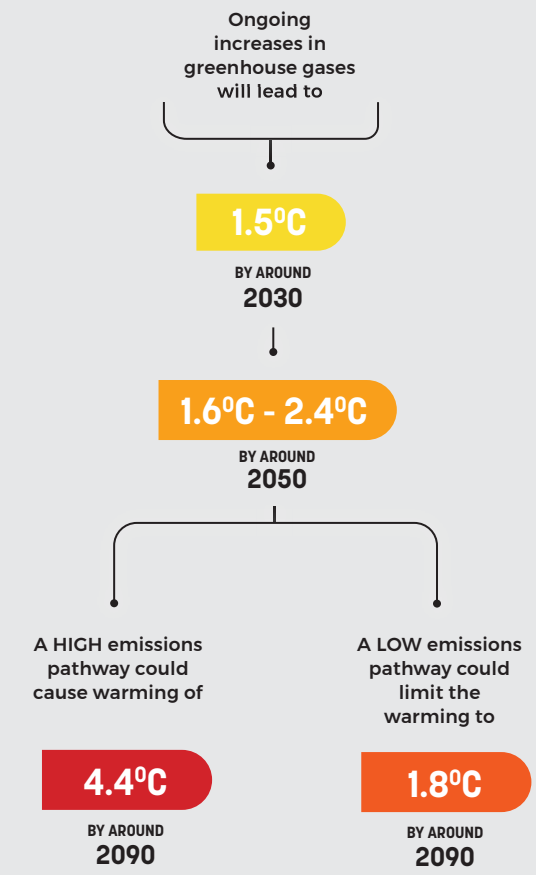
Rainfall is expected to increase over high latitudes and much of the tropics, but decrease over the subtropics including southern Australia. Climate change has caused widespread impacts on ecosystems and people.

Vulnerability differs substantially among and within regions, driven by patterns of socio-economic development, unsustainable ocean and land use, inequity, marginalisation and governance.

Progress on adaptation is uneven and there are increasing gaps between action taken and what is needed to deal with the increasing risks. Many cities and settlements have developed adaptation plans, but few have been implemented. Most financial investment continues to be narrowly directed at large-scale engineering projects after climate events have caused harm. Enabling conditions include political commitment; institutional frameworks; clear goals and priorities; enhanced knowledge of impacts and solutions; access to finance; monitoring; and evaluation.

Changes to the design and built form of cities can contribute to a reduction of the urban heat island effect and the impacts of heatwaves. Urban parks, open spaces, forests, wetlands, green roofs and engineered stormwater treatment help manage stormwater and wastewater.

Coastal engineering measures include sea-walls, groynes,



The surface has warmed by 1.1˚C on average, with greatest increases over land and near the poles.

breakwaters and tidal barriers. Architectural and urban design regulations, such as building codes and guidelines, facilitate climate resilient buildings. Passive cooling includes solar shading, window orientation, increased insulation, high-albedo materials and greater natural ventilation.

UPGRADING FACILITIES

Resilient ICT assets and networks can contribute to the robustness and stability of critical infrastructure and communities during disasters.

Resilient energy infrastructure includes changing engineering design codes and upgrading facilities to cope with new climatic conditions, building redundancy and robustness into systems, and preparation to ensure operation following extreme events.

Adaptation of road and rail networks includes re-routing, coastal protection, improved drainage and upgrading of rails. Improved flood management includes engineered flood protection, increased maintenance, land-use planning to reduce exposure, and better community awareness.

Key findings about mitigation: Greenhouse gas emissions between 2010 and 2019 are higher than in any previous decade. In 2019, 27 per cent of total emissions came from Eastern Asia, 12 per cent from North America and 10 per cent from Latin America and Caribbean. In 2019, about 34 per cent of total emissions came from the energy supply sector, 24 per cent from industry, 22 per cent from agriculture, forestry and other land use, 15 per cent from transport and six per cent from buildings.

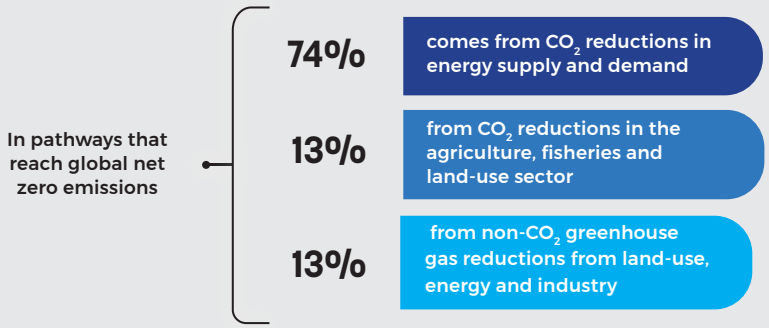
Without a strengthening of policies implemented by the end of 2020, greenhouse gas emissions are projected to rise beyond 2025, leading to median global warming of 3.2 degrees Celsius by 2100.

In pathways that reach global net-zero emissions, 74 per cent comes from carbon dioxide reductions in energy supply and demand; 13 per cent from carbon dioxide reductions in the agriculture, fisheries and land-use sector; and 13 per cent from non-carbon dioxide greenhouse gas reductions.

Reducing emissions across the energy sector requires major transitions. Reducing industry emissions needs coordinated action throughout value chains, including energy and materials efficiency, circular material flows and changes in production processes.

LEFT: Kevin Hennessy.

"REDUCING EMISSIONS REQUIRES MAJOR TRANSITIONS, INCLUDING LOW-EMISSION ENERGY SOURCES, IMPROVED ENERGY EFFICIENCY AND DEMAND MANAGEMENT."



CONSTRUCTION MATERIALS

Retrofitting existing buildings and innovations for new buildings include energy-smart building designs, low-emission construction materials and efficient appliances.

Changes in urban form, consumer behaviour and public transport can reduce demand for transport services and shift to more energy efficient transport modes. Electric vehicles, biofuels and hydrogen can support emissions reductions from shipping, aviation and heavy-duty land transport. Many strategies have co-benefits, including air quality improvements, health benefits and reduced congestion.

Accelerated and equitable action to reduce net emissions and adapt to climate change is critical to sustainable development. Engineers play an important role! ▶

KEVIN HENNESSY

LEADING THE TRANSITION

Peter Bryant
Board Chair and Managing Director, Clareo

WHEN IT comes to creating a greener future, Peter Bryant says he wants to present engineers with a challenge.

"It's no longer good enough [to say] 'I'm just doing my job' if you believe in the challenge that the planet faces," the Chair of growth and innovation firm Clareo Partners tells ***create***. "It's going to require people to step out of their comfort zone in their jobs as engineers and call out companies to say, 'We need to do these things, and these are possible.'"

Bryant is putting forward this challenge because engineers will be crucial to creating a sustainable future.

"What we're facing is not a regulatory and legislation challenge, but an innovation challenge," he says.

"Engineers of every ilk … are critical to doing the kinds of innovation that are required to make the transition happen."

These technologies include energy innovations such as grid-level storage, carbon sequestration, modular nuclear reactors and efficiency in existing infrastructure like buildings. But he cautions that there are multiple dimensions to the problem.

"We focus on emissions and that's not what a just transition to a cleaner energy future is about. We have to tackle emissions; we have to address social equality as we do this," Bryant says.

"There's a billion people in the world without electricity and another billion with inconsistent use. It's okay for us in the West; we aren't the big emitters anymore.

"How do we engineer solutions to get affordable, reliable, accessible energy – that's as clean as possible – to these people as fast as we can? It's not moral to exclude them from electricity, because that's the path to prosperity."

To make these changes, Bryant has identified four big ideas. One concerns the need for engineers and their leadership. The second involves inspiring and motivating more young people to enter engineering.

"You can make a real difference and we need you," he says. "There's a huge opportunity for young people to get into all the different aspects of engineering."

The third idea relates to cross-collaboration: bringing engineers from different sectors together.

"I'm a big believer in bottom-up change versus top down," he says. "Sometimes, engineering groups could start saying, 'We're collaborating across sectors; we're doing it at this level.'"

His fourth point concerns the social dimensions of responding to sustainability challenges. Developing nations, for instance, cannot always use the same energy solutions as countries like Australia, he says.

"We've got a lot of examples where the [industrialised nations] overengineer everything so it's really, really expensive," Bryant says. "How can you come up with a different solution that's affordable but still doesn't compromise safety or any other of those other issues?"

Bryant will present at Engineers Australia's Climate Smart Engineering conference this month, and as someone whose work involves advising minerals and energy companies on environmental and social governance, he has some ideas about how to transform this sector too.

"On the mining side, there's a significant amount of challenges," he says.

"If you want responsibly sourced minerals, there's a lot of innovation that needs to occur, both in the extraction – particularly copper, even in lithium and nickel – and the processing."

"HOW DO WE ENGINEER SOLUTIONS TO GET AFFORDABLE, RELIABLE, ACCESSIBLE ENERGY – THAT'S AS CLEAN AS POSSIBLE – TO THESE PEOPLE AS FAST AS WE CAN?"

That involves reimagining mining itself.

"You're not going to substitute a lot of these metals," he says.

Society needs to rethink how it looks at the mining sector, because you can't do this without mining. ▸

JONATHAN BRADLEY

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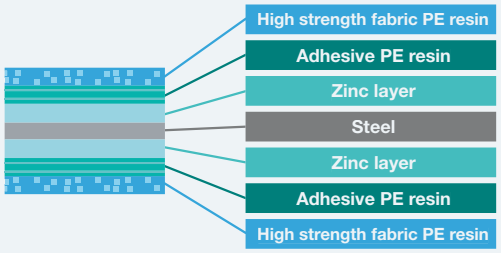

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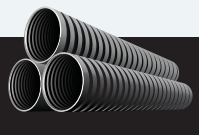

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ELECTRIFYING EVERYTHING

Saul Griffith
Founder and CEO of Otherlab

INVENTOR AND engineer Saul Griffith says there's very little reason to be optimistic about what we've done to the planet. Despite that, when it comes to climate change, he sees the need for proactive, positive stories.

"I am naturally an optimist and I think there are tentative reasons to be optimistic," he tells *create*.

Described by *The New Yorker* as "an extraordinarily innovative engineer who is trying to think his way around the limits of innovation," Griffith is the founder of Otherlab, a San Francisco-based research and design lab devoted to creative solutions in the fields of renewable energy and robotics.

After decades working in the US, he has recently returned to Australia, where he hopes the country can go from a climate laggard to a world-leading example of how sustainable policy can improve people's lives for the better.

Griffith's plan to remake the nation's energy landscape for a sustainable future is certainly an inspiring and forward-thinking one. His plan for a green future is a simple one: electrify everything.

And he believes the returns on an economy-wide shift to sourcing all our energy needs from renewable electricity will be remarkable.

"Electrification is going to be the majority of the solution outside of land use and agriculture. We just need to focus the mind on that, and build the policies and the technologies for that," he says. "You could supply nearly everyone in the world with an improved quality of life, do it with zero emissions, and do it on time to beat a two-degree target."

"YOU COULD SUPPLY NEARLY EVERYONE IN THE WORLD WITH AN IMPROVED QUALITY OF LIFE, DO IT WITH ZERO EMISSIONS, AND DO IT ON TIME TO BEAT A TWO-DEGREE TARGET."

Griffith identifies Australia as a potential world-leader when it comes to decarbonising our economy.

"Australia is unique globally because we are such an enormously out-sized primary producer – our peer nations are like Saudi Arabia, meaning we export multiples of the amount of energy we use in a domestic economy, so that makes us weird," he explains.

"The other thing that's unique about Australia is low population density, mild climate, enormous land mass, best-in-class-in-the-world wind and solar resources. So we have the easiest pathway to fix climate change of any country in the world, without doubt. If you can't solve it in Australia, you can't solve it anywhere."

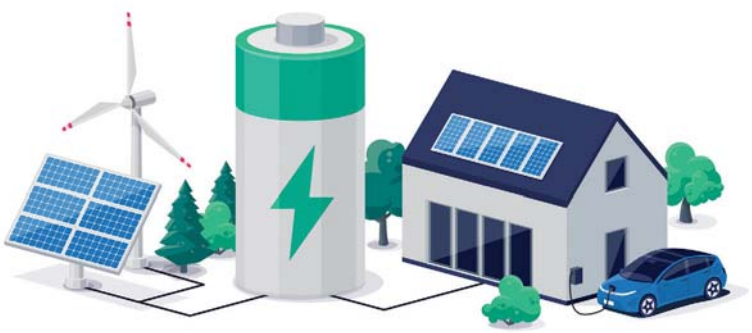
Griffith nominates a few areas in which Australia should be focusing its attention, noting that the nation already has a high take-up rate of rooftop solar cells.

"You need a similar set of policies around vehicle charging infrastructure, you need a similar set of policies around converting or building heat from natural gas to electric heat pumps, you need a similar set of policies around installing a profusion of batteries," he says. "Batteries, batteries, everywhere. Whether it's on the side of your house, whether it's in your car, whether it's on the distribution grid, we'll need a lot of storage."

As an engineer, Griffith understands how crucial other engineers will be to making the changes needed.

"I think becoming an engineer is an optimistic act. What is the job description of an engineer at large? Making machines that improve people's lives. And that's what we all sign up for. Here's the biggest opportunity to do that ever," he says. "We get to work at one of the most exciting points in history. We get to drive the transition. Are you telling me that the most important job in Australia for the next decade is being an engineer? That's me. I love that." ●

JONATHAN BRADLEY



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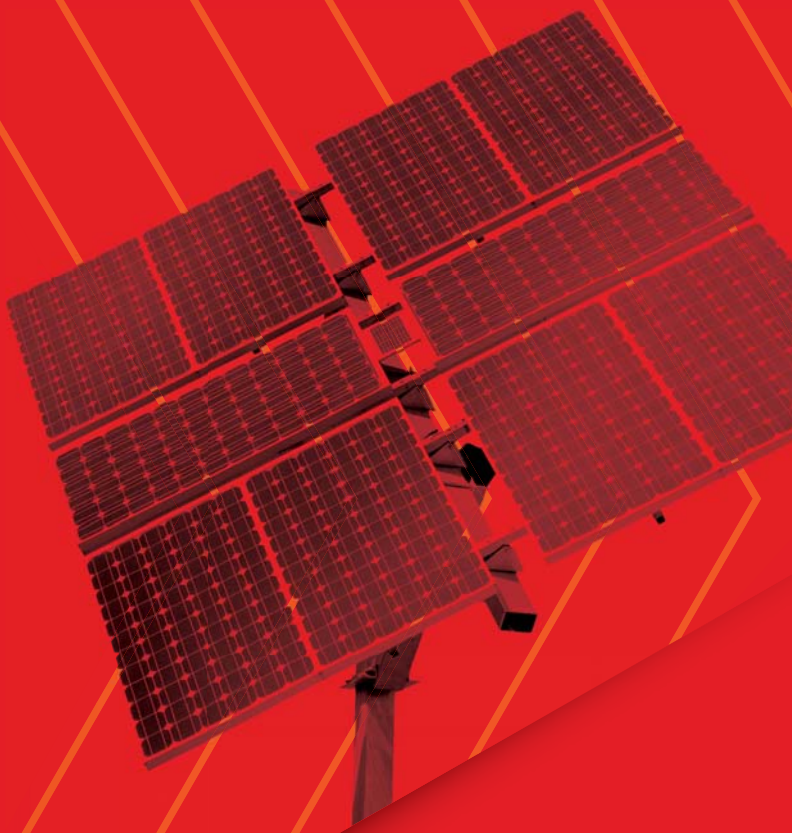

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WORDS BY **CHRIS SHEEDY**

A STORM IS BREWING

ROAD TO NET ZERO

THE PERFECT SOLUTION TO THIS UNIVERSITY'S STORMWATER MANAGEMENT CHALLENGES ARRIVED WITH THE DELIVERY OF ONE OF THE WORLD'S LARGEST PERCOLATION TANKS, DESIGNED TO SEND WATER DEEP INTO THE GROUND.

AS THE lowest lying area of UNSW Sydney's Kensington campus, the Village Green was previously an area of turf traditionally used as a cricket pitch.

However, during times of high water-flow after particularly large storms, the oval would be used for an altogether different sport: kayaking. "The area collects water from about 70 per cent of the campus," says Russell Druce, Hydraulic Engineer at UNSW Estate Management.

"The old system contained a small percolation trench, about 1300 m^3, just below the pitch surface. When that tank was overwhelmed with high flows, the pitch surface would fill up – there was sometimes water coming up to the edge of the picket fence all around the oval."

"That was actually part of the design. The oval collected water – it did the job of a detention basin. We have photos of people kayaking and using it as a water park, during some of those events."

UNSW Estate Management commenced the project in June 2021. It would replace the 1300 m^3 percolation trench with a new percolation tank with a volume of 17,000 m^3. The engineering challenges of such a project, at the centre of a live university environment, were numerous.

ABOVE: Duncan Crook.

The top three challenges were: removing pollutants from the inflow to prevent siltation; protecting the construction activities from stormwater run-off; and working next to the vibration-sensitive Newton Building.

TIME TO PERCOLATE

The new percolation tank at UNSW, which Druce describes as being "like a massive underground carpark, only without the line markings for car spaces", is a concrete cavern with an open base.

"We're talking about a tank that is designed to detain water, and also facilitate percolation into the ground, below," says Duncan Crook, the Arup civil engineer who developed the original concept for UNSW.

"We say percolate because we're talking about stormwater seeping into the ground below the tank and, ultimately, into the Botany Sands aquifer below.

"The concrete roof slab is supported by the external walls of the tank as well as intermediate columns founded on concrete footings to minimise settlement, which is why it looks a little bit like an underground carpark when you're inside it."

UNSW extracts borewater from the aquifer underlying the tank and has recently upgraded the borewater treatment plant on campus. This allows extracted treated borewater to be used for irrigation and other uses such as building air conditioning.

"The new system is much larger than the one we had before," Druce says. "It improves our capacity. We have had a few shortfalls, particularly in 2019 when we had several very hot days and had to isolate some of our buildings because we couldn't supply them with non-potable water.

"We had to revert to a potable system to make up the shortfall. It's good we have that capability, but we're much better off running on non-potable water or bore water."

An important design consideration was minimising the risk of sediment entering the percolation tank.

Sediment flushing into the tank could lead to progressive siltation of the base of the tank and reduce the rate of percolation over the longer term.

ABOVE: Russell Druce.
BELOW: The tank is built to be low maintenance.

To reduce this risk the project team implemented a stormwater quality improvement device (SQID). Stormwater drains were connected together and a SQID positioned immediately upstream of the tank. The SQID is a large, concrete chamber containing several internal weirs that progressively slow down the flow, trapping sediment, while floating debris is caught in baskets.

After the treated water exits the SQID, it enters a scupper chamber, which sits along the entire eastern flank of the percolation tank. This chamber is slightly deeper than the rest of the tank and once again slows flows and collects any residual sediment not contained in the SQID.

"That scupper chamber does all the heavy lifting," Druce says. "Any additional flows from a higher intensity storm flood out into the larger tank. As a whole the tank accommodates the one per cent ➤

WHEN THAT TANK WAS OVERWHELMED WITH HIGH FLOWS, THE PITCH SURFACE WOULD FILL UP – THERE WAS SOMETIMES WATER COMING UP TO THE EDGE OF THE PICKET FENCE ALL AROUND THE OVAL."

ABOVE: Geoffrey Lim.
LEFT AND BELOW: The tank is designed to eliminate settlement.

annual exceedance probability – AEP – storm, which will fill the tank to about 95 per cent."

A supplementary measure is a permeable geofabric placed over the earth floor, with a thin layer of washed river gravel on top. This is to allow further filtration of the water before it enters the ground. The SQID, scupper chamber and base protection measures work together to help prevent siltation.

The ultimate destination for the stormwater is the Botany Sands aquifer which UNSW, as a major land manager in the area, has a responsibility to preserve.

"At the university we draw bore water to provide about 40 per cent of our non-potable water needs. The aquifer is a massive resource, not only for cost but also from a sustainability standpoint. So the more water we put into the aquifer, the more we're ensuring that the aquifer is going to provide that resource in the future," Druce says.

FLOOD-PROOF CONSTRUCTION

Ironically, the very event the infrastructure was being created to handle – a major storm – was also the event that could slow or disrupt the project during construction.

"We put a lot of thought and planning into managing water away from where the construction was happening," Crook says. "We put up several lines of fences and barriers, such as earth mounds, to stop stormwater from barrelling into our site, as well as temporary overflow measures."

On paper, the solution looks like several lines of defence on a battlefield, against attacks from the north and south.

"We had to make sure there was low chance of stormwater spilling into the oval," Crook says. "Unless it's extreme rain, in which case there's nothing we could do. The only effective way to deal with this risk was to get on with the job as fast as we could, to get the tank built before the rain came."

One interesting challenge, says Geoffrey Lim, UNSW Estate Management's Project Manager, was that the site was adjacent to the Newton Building.

"This building houses some of the top research projects in the University, several of which also happen to be highly vibration sensitive," Lim says.

"One of our challenges during construction was to dig a giant hole and construct a massive tank ▸

"THE ONLY EFFECTIVE WAY TO DEAL WITH THIS RISK WAS TO GET ON WITH THE JOB AS FAST AS WE COULD, TO GET THE TANK BUILT BEFORE THE RAIN CAME."

KEY FACTS

17,000 m^3 (**17** million litres), equivalent to **6.5** Olympic swimming pools

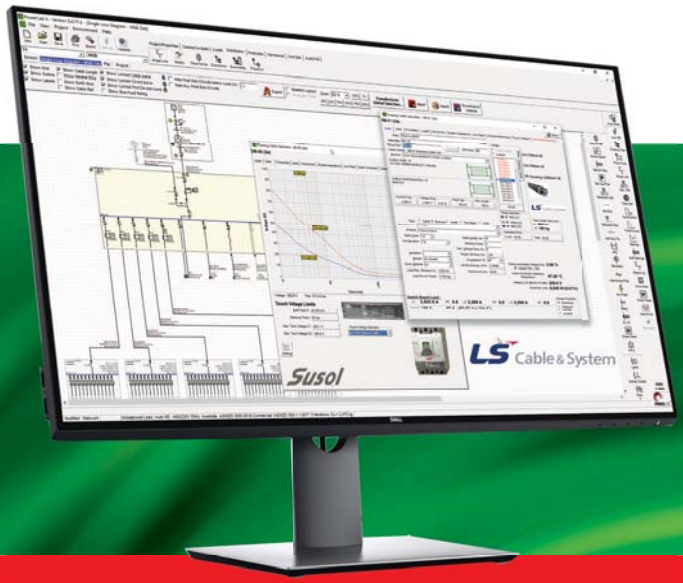
104 m long x **48** m wide x **3** m deep

From full, the tank would take approximately **36** hours to empty through percolation

The Botany Sands aquifer stretches from Moore Park to Botany Bay, and is about **7 m** below ground level

The tank accommodates all storm events up to and including the **1%** annual exceedance probability (formerly referred to as the "one in 100-year event"), plus an allowance for increased rainfall intensities due to climate change

POWERCAD-5



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- ARC Fault Check
- ARC Flash calculations
- Harmonic Analysis
- Network Resonance Check
- Harmonic Mitigation
- Power Factor Correction
- Active Harmonic Filter Sizing
- Passive Harmonic Filter Sizing
- Substation Sizing
- Standby Generator Sizing
- Single Line Diagram Display
- Single Line Diagram Export to AutoCAD®
- L.V.Distribution Network Modelling
- Bus-Tie modelling
- Check metering modelling
- Automatic Mains and Submains Cable Selections
- Automatic Final Subcircuit Cable Sizing
- Variable Speed Drives
- Display Load Starting Current Profile
- AutoCAD® Interface for Loads Input
- Light Fitting and Motor Libraries
- Reports with Print Preview
- Direct Online Support
- Standards AS/NZS, IEE, BS, CP5, SAS and IS (India)

Compliance Checking

- ✓ **clause 2.5.5.3 arcing fault clearing capacity of protective devices for feeds of 800amps and above**
- ✓ **clause 2.5.7.2.3 supply circuit discrimination with option for checking protective devices less than 250amps**
- ✓ **clause 5.3.3.1.1 protective earth conductor thermal stress check**
- ✓ **clause 5.7.4 earth system impedance check at 0.4s and 5 sec disconnect times**

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while sensitive research was being carried out on our doorstep."

Several vibration monitors were installed within the Newton Building and vibration was monitored and regularly reported throughout the project.

Vibration reports and timings were sent to all of the building occupants on a fortnightly basis, so they could be compared against any research anomalies occurring during those times.

"We held fortnightly stakeholder engagement meetings, not just with those in the Newton Building but also in other surrounding colleges, just to make sure they all had a chance to voice any concerns and remain informed," Lim says. ●

"ONE OF OUR CHALLENGES DURING THIS CONSTRUCTION WAS TO DIG A GIANT HOLE AND CONSTRUCT A MASSIVE TANK WHILE THIS SENSITIVE RESEARCH WAS BEING CARRIED OUT ON OUR DOORSTEP."

PROJECT PLUSES

The university expects numerous benefits now the percolation tank is up and running. These include:

WATER AND ENVIRONMENTAL

- The natural water cycle benefits as stormwater is directed into the aquifer.
- The additional groundwater could reduce UNSW's dependency on the public water supply.
- Proactive treatment of stormwater removes pollutants, maximising the quality of water draining into the aquifer.
- Downstream flood risk is reduced as greater volumes of stormwater are captured, also satisfying Randwick City Council for onsite detention.

STUDENTS AND STAFF

- All-weather sports pitches and other modern facilities have now been established within the Village Green area.
- The new sports pitches are flood resilient, minimising downtime after rainfall.
- The infrastructure is below ground, so is unobtrusive.
- Telemetry equipment within the tank monitors performance and provides a teaching aid for students.
- The project details are now available to students of civil engineering and geotechnical engineering as a study resource.

UNIVERSITY OPERATION AND MAINTENANCE

- Designed to be low maintenance, the new stormwater system minimises operational costs and disruption.
- The tank is engineered to eliminate the risk of settlement and maximise design life.
- Regular cleaning and periodic inspection are able to be conducted to optimise long-term performance.
- The tank size design helps future-proof campus developments.

All in all, it's an elegant but surprisingly simple solution, apart from the project's scale. The university has boosted its water resilience whilst ensuring the recharge of a vital aquifer.






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PICTURED: AirSeed drones identify the best places to plant the seeds.

IMAGE: AIRSEED TECHNOLOGIES

THIS AUSTRALIAN START-UP IS COMBINING DATA AND DRONE TECHNOLOGY WITH ITS PROPRIETARY PODS TO COMBAT CLIMATE CHANGE AND BIODIVERSITY LOSS.

ROAD TO NET ZERO

TOP SEED

WORDS BY **SUSAN MULDOWNEY**

THE AUSTRALIAN Government's recent State of the Environment report delivered a dire warning for the future of Australia's unique biodiversity.

At least 19 of our ecosystems reveal signs of collapse or near collapse. We have lost more mammal species than any other continent and have one of the highest rates of species decline in the developed world, with habitat destruction and clearing identified leading causes of extinction.

With manual reforestation practices unable to keep up with the pace of decline, a number of innovative, drone-driven start-ups are rising to the challenge.

Australian-based AirSeed Technologies is a leading example.

DRONES TO THE RESCUE

A mechanical engineer with a background in the automotive and aerospace industries, Walker says his idea for AirSeed Technologies was driven by a desire to create a "business that had an impact".

"I've always been passionate about the environment, and I was looking at the deforestation in the Amazon and other places in the world and thought about how we could use technology to make a difference," he says.

Data from Brazilian space agency INPE shows deforestation destroyed the equivalent of more than two football fields each minute in the country's Amazon rainforest in 2020.

Meanwhile, Wildlife Society statistics show Australia loses an Melbourne Cricket Ground-sized area of forests and bushlands every 86 seconds.

"WE NEED TO ENSURE THAT WE RESTORE ECOSYSTEMS THE RIGHT WAY, INSTEAD OF JUST GOING OUT THERE AND PLANTING FOR THE SAKE OF SEQUESTERING CARBON."

Combining drones, artificial and data-driven intelligence with a proprietary seed pod biotechnology, AirSeed aims to increase natural habitat and carbon sequestration through global scale reforestation.

"The last 12 months has seen a complete turnaround in not only the need for [environmental and social governance] targets and net-zero goals, but also a stronger focus on restoring lost biodiversity," says AirSeed Technologies Director and CEO Andrew Walker, who founded the company with geospatial data specialist Andries Louw in 2018.

"But we need to ensure that we restore ecosystems the right way, instead of just going out there and planting for the sake of sequestering carbon."

AirSeed Technologies can disperse seed pods 95 per cent faster than manual planting at 20 per cent of the normal cost. It began trials of its drone technology in Australia and South Africa in 2019 and launched a crowdfunding campaign the following year, raising over $437,000 from more than 250 equity investors.

In June this year, the company raised $2.1 million in seed capital and has received a number of grants, including $543,650 from the Australian Research Council to fund a collaboration with Macquarie University researchers and the Royal Botanic Gardens and Domain Trust to restore native vegetation in degraded land.

"The crowdfunding helped us to raise awareness and basically invite people to get ▸

behind us; our tagline is 'Join our mission: restore the planet'," Walker explains.

"It also helped us to grow our team and leverage partnerships with academic institutions, but the latest round of funding has been fundamental in advancing our biotech to a point where we're now ready to scale."

Today, AirSeed's projects include collaborations with landholders and corporates on large-scale projects, with reforestation playing a vital role in carbon credit schemes. It recently teamed up with Telstra on a technology trial to plant and manage the reforestation of 240 ha of land at Yarrowyck in northern NSW to help offset the telco's carbon emissions.

"WE USE DIFFERENT TYPES OF ORGANIC COMPONENTS THAT ARE GREAT FOR HOLDING WATER AND MICROBIAL COMMUNITIES THAT WE PUT INSIDE THE SEED POD THAT HELP SUPPORT THE SEED ONCE GERMINATED."

The project includes planting 158,000 native trees and shrubs, which are expected to store approximately 160,000 t of carbon dioxide over the next 25 years.

RESTORING BIODIVERSITY

AirSeed Technologies uses a combination of artificial intelligence and GPS technology to plant 40,000 seed pods per drone each day.

Machine-learning technology enables the drone to optimise planting by matching certain species with their ideal typography, irrigation conditions and soil health.

Louw explains that pre- and post-planting analysis is a key element in the AirSeed solution.

"Using remote sensing, our proprietary software and machine learning algorithms, we are able to identify the best places to plant specific species while also identifying the places where not to plant, such as rivers, roads, fallen trees and depressions in the ground that may indicate harmful weeds."

ABOVE: Engineer Pieter Van Zyl (L) and AirSeed Cofounder Andries Louw. LEFT: AirSeed CEO Andrew Walker.

Once these factors have been identified, AirSeed's software creates a flight path and tells the drone where to plant certain species in certain locations. "Each drone in any one flight can plant up to 16 different species, which is a key part of the process – and a big part of our business is the manufacturing of the seed pods and the technology behind that," says Walker.

AirSeed's seed pod technology represents the majority of its intellectual property, so what Walker can reveal is that it's a way of "encapsulating a seed inside of a seed pod".

"We use different types of organic components that are great for holding water and different types of microbial communities that we put inside the seed pod, such as probiotics, that help support the seed once germinated, along with different types of nutrients and minerals," says Walker.

"It's a way of stimulating the early-stage growth and reducing vulnerability to ants and other types of insects, for instance, that could potentially damage or kill the plant once it got to a certain size."

AirSeed drones also log the GPS location of every seed pod planted to assist with monitoring and surveying.

"We don't just plant and then walk away," says Walker. "We ▸

IMAGE: AIRSEED TECHNOLOGIES.

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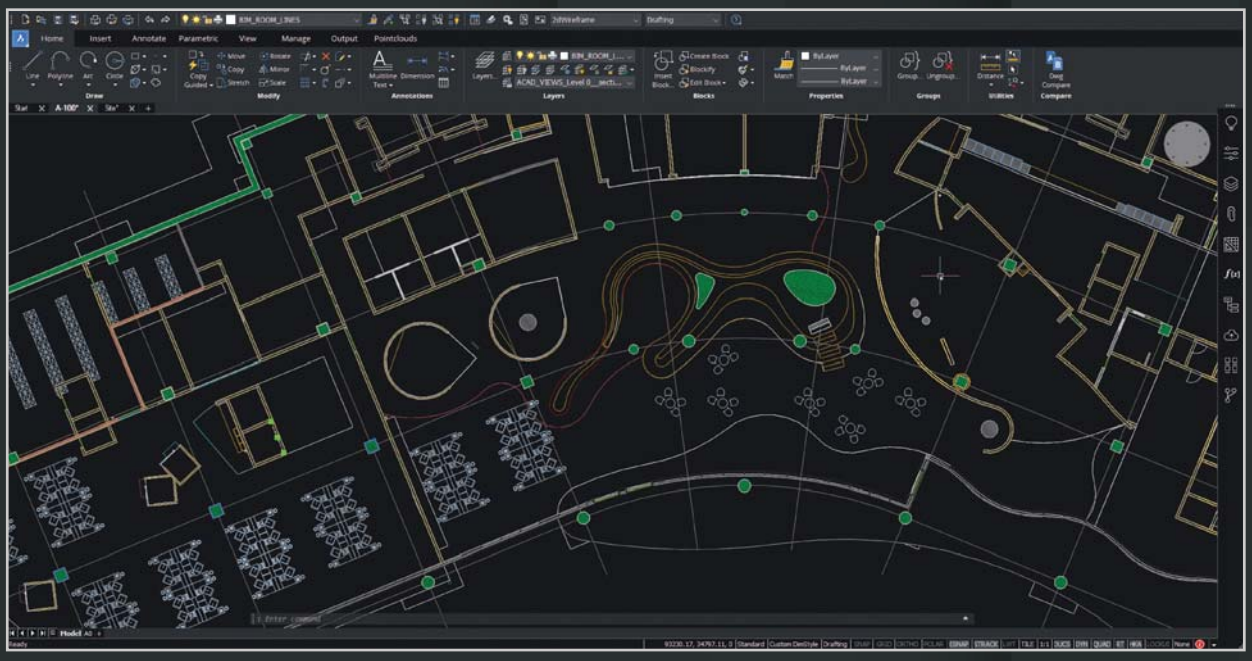

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"WE DON'T JUST PLANT AND THEN WALK AWAY. WE ENGAGE IN A PROJECT FOR TYPICALLY UP TO THREE YEARS AND USE REMOTE-SENSING DATA TO PROCESS THE ALGORITHMS THAT TELL US WHERE WE PLANTED."

engage in a project for typically up to three years and use remote-sensing data to process the algorithms that tell us where we planted and what's growing and where there are invasive weeds, because weed load is one of the biggest causes of failure."

Where invasive weeds are detected, AirSeed's technology can identify the variety and the type of pesticide to administer at specific volumes.

"Low-toxicity spot-spraying information is passed to another drone that flies out and does the spraying," says Walker.

Most saplings take at least five years to mature beyond the point of vulnerability to pests and predators.

Walker says AirSeed's success rate varies, depending on the environment and the plant species planted.

"Project types have their nuances, but 20 to 40 per cent is our target ratio," he says.

"Seedlings cultivated in a nursery with people going out and digging a hole and planting them present an expensive and not very scalable process, but it does yield really high success rates of about 80 per cent.

"Our goal has always been about finding a balance between creating the technology, the delivery systems, the software and the machine learning to facilitate the scale and concentrating on the science behind the biotech to promote early-stage growth and success rates."

REPLANTING THE GLOBE

The United Nations International Panel on Climate Change estimates that the world has only 10 years to prevent the most catastrophic effects of global warming.

Global energy-related carbon dioxide emissions rose by six per cent in 2021 to their highest level of 36.3 billion tonnes. While planting trees is currently the best way to sequester carbon, the scale of the challenge requires billions of trees to be planted each year.

Dendra Systems

Dendra Systems is another Australian-based company combining expertise in ecology and land restoration with artificial intelligence and drone technologies for reforestation.

Formerly known as BioCarbon Engineering, the company was founded by Dr Susan Graham and Matthew Ritchie in 2014. Its work includes collaborating with mining companies, such as BHP, Glencore and Rio Tinto, to restore degraded habitats.

With 10 drones flying in a swarm, Dendra says it could plant as many as 300,000 trees per day.

In 2020, Dendra raised $10 million to further its land rehabilitation and biodiverse ecosystem restoration work. Last year, it collaborated with biodiversity monitoring firm NatureMetrics and systems change company Systemiq to form Biostream.

The venture is competing for XPrize Rainforest, a five-year, US$10 million competition to enhance understandings of the rainforest ecosystem. It was recently announced as a semi-finalist.

IMAGE: AIRSEED TECHNOLOGIES

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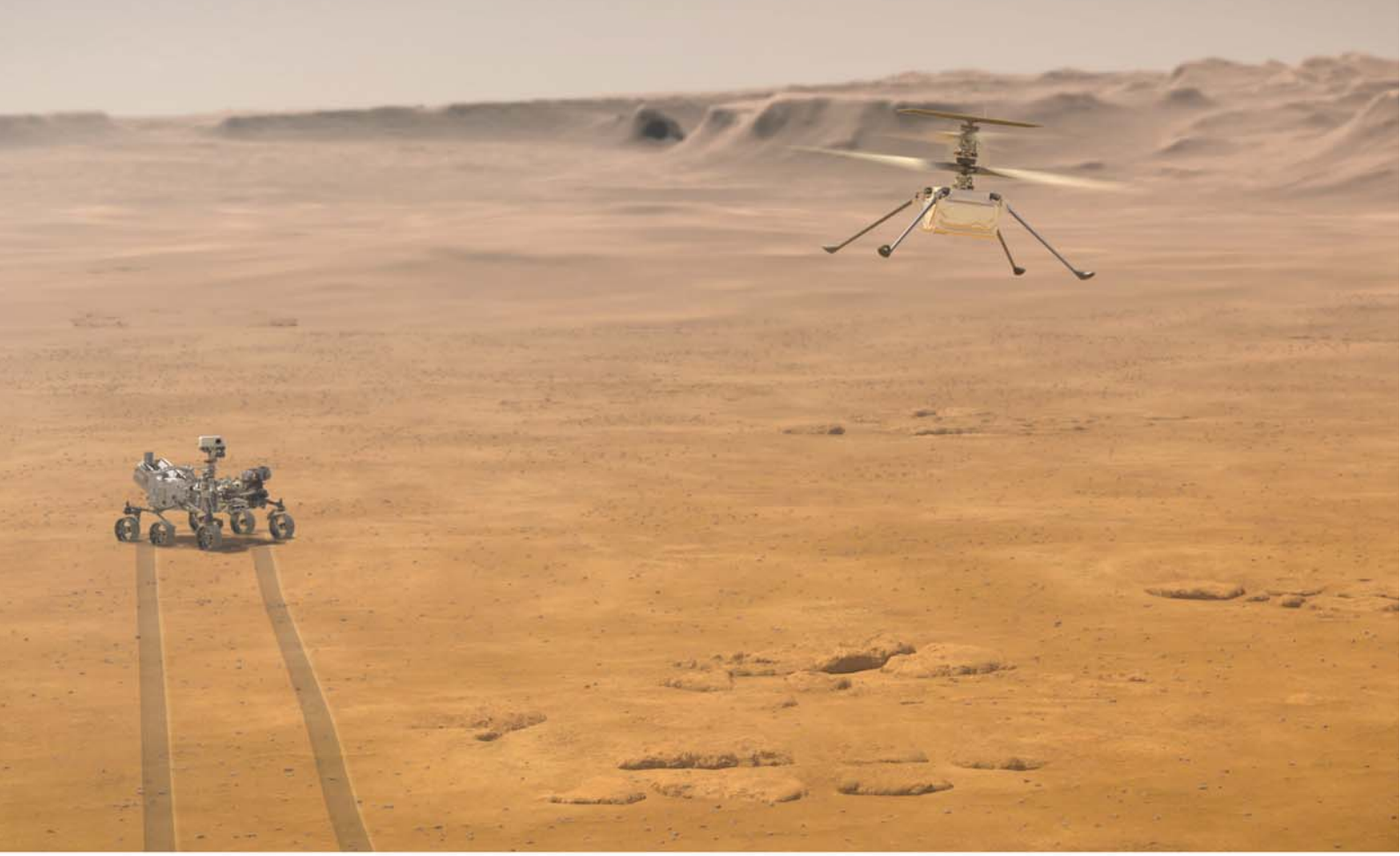
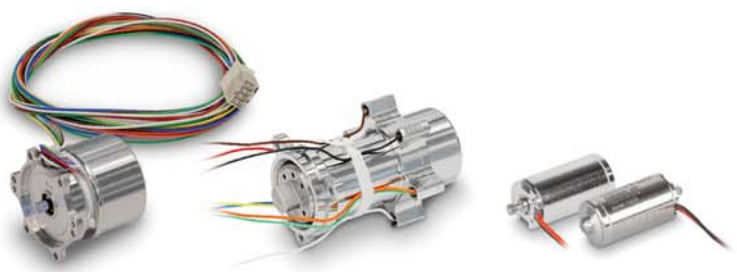


maxon motors on Mars



DC motors from maxon have been used in virtually all successful robot missions on Mars. More than 100 of these drives are already on the Red Planet including the Perseverance rover and the helicopter drone Ingenuity.

Ingenuity Helicopter
Ingenuity made history when the first powered, controlled flight took off in the extremely thin atmosphere of the Red Planet. Subsequent flights of incrementally farther distances and altitudes have also been a success. There are six 10mm brushed DCX micromotors used to control the tilt of the rotor blades, which determines the direction of Ingenuity's flight. The drone weighs 1.8 kilograms, is solar powered, and is designed to take aerial photographs. This experiment primarily tested the concept for further drones of this kind.

Perseverance Rover
Perseverance rover's mission is to collect soil samples for analysis on Earth later, including looking for signs of previous life. maxon's precision DC motors and gearheads are in numerous mission-critical tasks. They power the small robotic arm in the rover which moves the valuable samples from station to station. The motors are based on our standard industrial products: a flat, brushless DC motor and a planetary gearhead with a diameter of 22mm. maxon's brushless DC motors are also used for sealing and depositing the sample containers.

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Precision Drive Systems

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While AirSeed's aim is to plant more than 100 million trees in Australia and Africa by 2024, its work is part of a broader automated reforestation movement.

In Canada, for instance, reforestation start-up Flash Forest uses aerial mapping software, drone technology, automation and ecology to plant seeds at a rapid rate, with a focus on permanent, diverse forests, rather than managed forests and monocultures.

"WE'RE DOING THE WORK THAT BIRDS AND SMALL ANIMALS WOULD NORMALLY DO IN BRINGING SEEDS BACK INTO THE LANDSCAPE."

The work of US-based DroneSeed includes restoring wildfire-ravaged land. Its drones drop seeds housed in pods made from plant fibre that contain nontoxic elements, such as spicy pepper, to deter rodents and other mammals.

DroneSeed recently acquired Silvaseed, a 130-year-old seed and seedling supplier, to ensure a steady and scalable supply to restore forests.

Australian-based start-up Lord of the Trees has been automating reforestation since 2019. Its founder, Aymeric Maudous, says its miliary-class drones weigh about 65 kg and take two people to manoeuvre.

"One drone can plant 158,400 seeds a day," he says. "We're also working with the federal government as one of the first responders after bushfires. You'd normally have to wait three months before going into a landscape that had just burned because of the heat and toxic fumes generated by ash.

Maudous adds that the company is working on a seed pod that is heat resistant up to 60 technology and ecological research. In March this year, it announced a $1.3 million pre-seed capital raise.

ABOVE: Aymeric Maudous checks his seed pod which is like a backpack full of nutrients.

Lord of the Trees

Reforestation start-up Lord of the Trees was launched by Sydney-based Aymeric Maudous in 2019 after learning — via a David Attenborough documentary — how the Galápagos Islands had been populated by plants over millions of years via seeds carried by the wind or dropped from the air by birds. Today, Lord of the Trees has switched the birds for drones, AI

Lord of the Trees works with landowners such as mining companies, governments and farmers on reforestation projects, forest maintenance projects and planting in bushfire-damaged regions.

Its projects include recovering degraded land and reversing the spread of desert in Western Australia's Central Wheatbelt with technologies such as drones, AI and robots.

It is also supporting the restoration of native trees in Sumatra to serve as habitat for numerous endangered species, including orangutans and tigers.

"Our seed pods are like a backpack full of nutrients for seeds for germination and the best chance of survival," says Maudous.

"They're also protected from creatures that might like to eat them. There are no harsh chemicals, they just taste bad, so they'll spit them out."

Maudous says the company is seeking ways to share its technology in order to scale its reforestation projects across the globe.

"We'd like to enable organisations to lease our technology and to connect to our system to pre-program drones," he says.

"When it comes to climate change, I want to be part of the solution."

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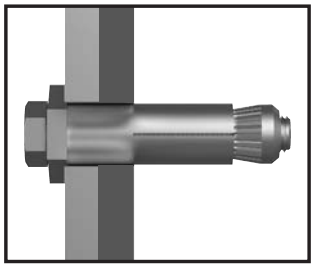

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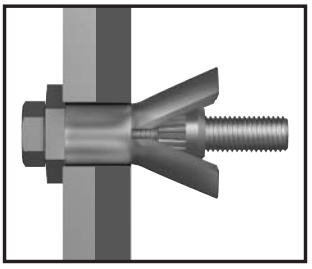

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ABOVE: An AirSeed drone uses AI and GPS to plant 40,000 seed pods a day.

IMAGE: AIRSEED TECHNOLOGIES.

degrees, and that will enable the drones to go in just days after a bushfire and start reseeding.

"We're doing the work that birds and small animals would normally do in bringing seeds back into the landscape," he says.

FORESTS FOR THE FUTURE

Walker says AirSeed's key point of difference is its biotechnology.

"Our seed pods can be manufactured remotely, so, as an example, we could put a container on a ship to the Amazon and be able to manufacture the seed pods in situ at a planting site, in the middle of a forest, completely off the grid, with minimal people required to restore tens of thousands of hectares," he says. "This is a really powerful tool, not just from a commercial sense, but from an environmental sense as well, because we'll be able to address a need that human capital can't solve."

"THIS IS A REALLY POWERFUL TOOL, NOT JUST FROM A COMMERCIAL SENSE, BUT FROM AN ENVIRONMENTAL SENSE AS WELL, BECAUSE WE'LL BE ABLE TO ADDRESS A NEED THAT HUMAN CAPITAL CAN'T SOLVE."

AirSeed's current focus is scaling its business and it plans to expand into global markets in 2024.

Walker says the ultimate goal is to continue pushing the technology to the forefront of industry use while remaining true to its mission of restoring the planet.

"It's taken so long to convince people to change their mindset about climate change and we've got such a massive uphill struggle to restore what we've taken away," says Walker.

"We need to start doing things differently and we have the technology for this, so we need to keep pushing the needle further forward." ●

WORDS BY **MICHELLE WHEELER**

FUEL FOR THOUGHT

INSIDE THE CONSORTIUM OF MINING COMPANIES SHAPING THE FUTURE OF GREEN HYDROGEN IN AUSTRALIA.

EVERY THREE months, one meeting sees some of Australia's biggest miners set their usually competitive natures aside. Instead, Anglo American, BHP, Fortescue and engineering consultancy Hatch meet to openly share what they're working on, trends and key challenges they're facing.

It's known as the Green Hydrogen Consortium, and it's shaping the decarbonisation of Australia's mining industry.

Lana van Wyk, a chemical engineer who represents Hatch on the group, says the consortium aims to understand how the use of hydrogen and its supply chain will evolve in the mining industry.

"There's a lot of sharing the type of projects we work on, and sharing our challenges and our ideas," she says.

Van Wyk, a principal at Hatch, says the biggest issue for the miners is whether to develop a common supply chain or go it alone.

"The key question really is does everybody build their own hydrogen electrolyser in their own backyard on their own mine," she says. "Or do we leave value on the table if we do that? Do we actually need to collaborate as an industry?"

FUTURE INVESTMENT

Hydrogen is produced by running electricity through demineralised water, splitting it into hydrogen and oxygen.

When this electrolysis is achieved through renewable resources like solar, wind or geothermal energy, the result is green hydrogen.

While the consortium operates with strict competition rules – they can't do anything that would breach the *Competition and Consumer Act* – van Wyk says the group wants to find places to collaborate.

"I think we're all looking for that one problem that we all face in our energy transition that we can perhaps solve together," she says.

LEFT: Lana van Wyk, Hatch.

"So it's really about building that shared trust and understanding around the key problems, so that we can then decide how we want to solve that problem together."

Much of the consortium's focus to date has been finding an alternative to diesel fuel.

"Fuel displacement is a huge headache for the mining companies," van Wyk says. "The amount of diesel that's consumed, for example, in the Pilbara is 6000 megalitres every year.

"That's just for the iron ore industry. The carbon footprint of that's obviously immense, and then trying to displace that diesel is a big challenge."

PROMISE AND CHALLENGES OF GREEN HYDROGEN

Green hydrogen is currently costly, technically challenging and can be hazardous. It's up to three times more expensive than supplies from gas, although some claim the cost of production from renewable sources could reach parity by the end of the decade.

For van Wyk, the timing of green hydrogen becoming economical is "horses for courses".

"There are specific applications in remote areas where bringing diesel in and storing it is now on par with producing hydrogen at site and storing hydrogen onsite.

"Just because of the high cost of diesel in those remote areas. And most mines are in ▸

"SO IT'S REALLY ABOUT BUILDING THAT SHARED TRUST AND UNDERSTANDING AROUND THE KEY PROBLEMS, SO THAT WE CAN THEN DECIDE HOW WE WANT TO SOLVE THAT PROBLEM TOGETHER."

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extremely remote areas. So there's definitely applications for diesel displacement that are already economic. There's no question about it."

Van Wyk says Hatch recently completed a study for Grange Resources in Tasmania that estimated the cost of green hydrogen production at between five and six dollars a kilo.

HYDROGEN PRICE

In applications like the use of natural gas for pelletisation and calcination, it's a price that makes the business case hard.

"In those areas, we're going to need a hydrogen price closer to two dollars," van Wyk says. "Is two dollars going to happen? We think it could happen.

"The tipping point for it is the penetration of renewable energy into the energy markets.

"There's a certain point when we have enough wind and enough solar, the price of the grid will be low enough to really supply that hydrogen."

One model being investigated by the Heavy Industry Low-carbon Transition Cooperative Research Centre (HILT CRC) is producing green hydrogen during periods of peak power generation.

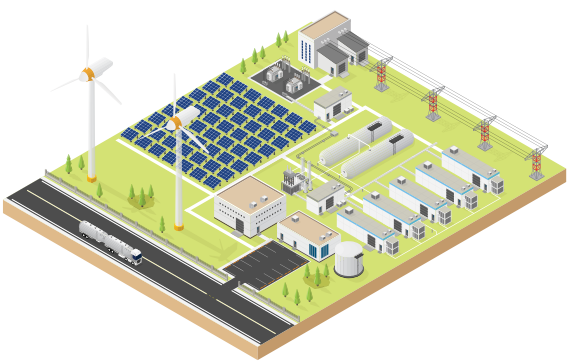
"IT WILL REQUIRE EVERY ENGINEERING SKILL THAT WE HAVE AT SCALES THAT WE'VE NOT SEEN BEFORE."

At these times, there is excess electricity and the grid needs to be curtailed. "Certainly just plugging into a grid electrolyser right now and producing does not make any economic sense," van Wyk says.

"It's way too expensive But if it's on its own grid, or you run it during critical curtailment periods – which you can, electrolysers are quite flexible, you can switch them on and off as you like – there is certainly a business case to be made.

"Because suddenly you're running with free or negative-priced electricity."

ABOVE: The nuGen Zero Emission Haulage Solution is a hydrogen-powered ultra-class mine haul truck from Anglo American, said to be the world's lightest 510 t truck.



A NEW GENERATION OF ENGINEERS

With green hydrogen, we're seeing an extraordinary linkage between fuel, transport systems and energy systems," van Wyk says.

She believes we'll need almost every discipline of engineering, including electrical, chemical, mechanical, civil and marine.

"It will require every engineering skill that we have at scales that we've not seen before," van Wyk says. She hopes climate change will be a catalyst for more young people to choose engineering as a career.

"There's a generation of engineers that don't want to work in mines, they don't want to work in fossil fuel, they don't want to work in coal-fired power generation," van Wyk says.

"This hydrogen in renewable energy industry is really where they can now go, and they know they're contributing to something positive.

"They're really making a change, and they're helping decarbonise the planet." ●

HYDROGEN-POWERED TRUCKS

One area the consortium is following closely is the development of hydrogen-powered trucks and associated supply chains.

In May, Anglo American unveiled a prototype of the world's largest hydrogen mine truck. The hydrogen-battery hybrid truck was designed for a platinum mine in South Africa, and is capable of carrying a 290-tonne payload. It generates more power than its diesel predecessor.

"All of the consortium has been following this with Anglo and seeing them make their advancements and engineer the truck and trial it," van Wyk says. "So it's quite exciting to have seen Anglo bring that project to life."

Van Wyk says Fortescue is also trialling a smaller hydrogen truck on site. "The consortium has been a fantastic opportunity for us to learn from each other because everybody is looking at a slightly different perspective," she says.

"And when you put them all together, then suddenly you can start to see how this picture emerges, of what future hydrogen supply chains for truck fleets might look like."

IMAGE:ANGLO AMERICAN

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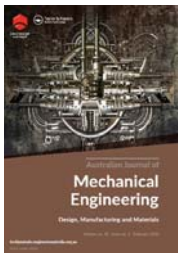
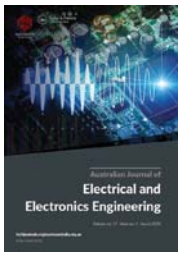
HIGHLIGHTS FROM AUSTRALIA'S MOST UP-TO-DATE ENGINEERING RESEARCH



SENSITIVITY ANALYSIS OF STRESS DISTRIBUTION IN BICYCLE FRAME

Journal: *Australian Journal of Mechanical Engineering*
Author: R. S. Gautam

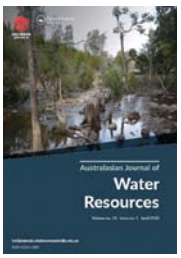
This paper presents a sensitivity analysis of stress behaviour in the elements of a bicycle frame with a diamond structure. To achieve this goal, stress on each element of the diamond frame was derived in the form of analytical expressions in terms of design parameters by imposing a static equilibrium condition on a 2D representation of the frame.



A FAILURE PREDICTION METHOD OF POWER DISTRIBUTION NETWORK BASED ON PSO AND XGBOOST

Journal: *Australian Journal of Electrical and Electronics Engineering*
Authors: J. Fiang, H. Wang, F. Yang, K. Yin, X. Lin & M. Zhang

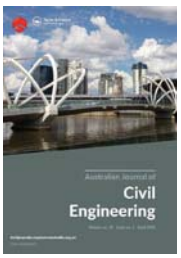
Power distribution networks are an important link between the end of a power grid and the users. Precise predictions on the risk probability of the distribution network in severe weather could provide utilities with a reference for daily operation and maintenance arrangements. A failure risk prediction of power distribution network method based on particle swarm optimisation and extreme gradient boosting tree algorithm is proposed.



THE SPATIAL DISTRIBUTION AND DETERMINANTS OF IRRIGATORS' PRICE CHOICES FOR WATER ENTITLEMENT TRADING

Journal: *Australasian Journal of Water Resources*
Author: J. Haensch

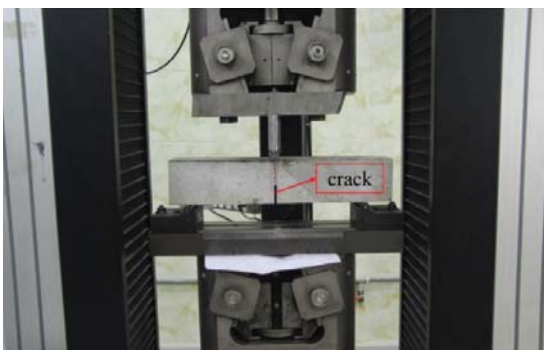
This article aims to assess the determinants of irrigators' values for their water — their price choices for selling and buying of water entitlements. Focusing on spatial determinants and how irrigators' price choices vary spatially, it finds that irrigators value their water differently if they own it compared to if they were going to own it in the future.



Feasibility study of reusing wash water and steel fibre simultaneously on workability, mechanical properties and fracture toughness of concrete

Journal: *Australian Journal of Civil Engineering*
Authors: M. Taghizadeh, G. Asadollahfardi, A. M. Salehi & J. Akbardoost

Every day, huge amounts of wash water are produced by concrete batching plants and concrete mixer trucks. As such, wash-water reuse can be a method of saving water. This experimental work was conducted to determine the feasibility of using wash water in normal concrete and fibre-reinforced concrete. Tests for workability and compressive, tensile, and flexural strengths, as well as fracture toughness of concrete specimens, were carried out. The paper finds that when using wash water and steel fibre in a concrete sample instantaneously, fracture toughness increases by 49 per cent.



RIGHT: THE SINGLE-EDGED NOTCHED BENDING SPECIMEN PRODUCED NORMAL AND FIBRE CONCRETE WITH TAP WATER AND WASH WATER.

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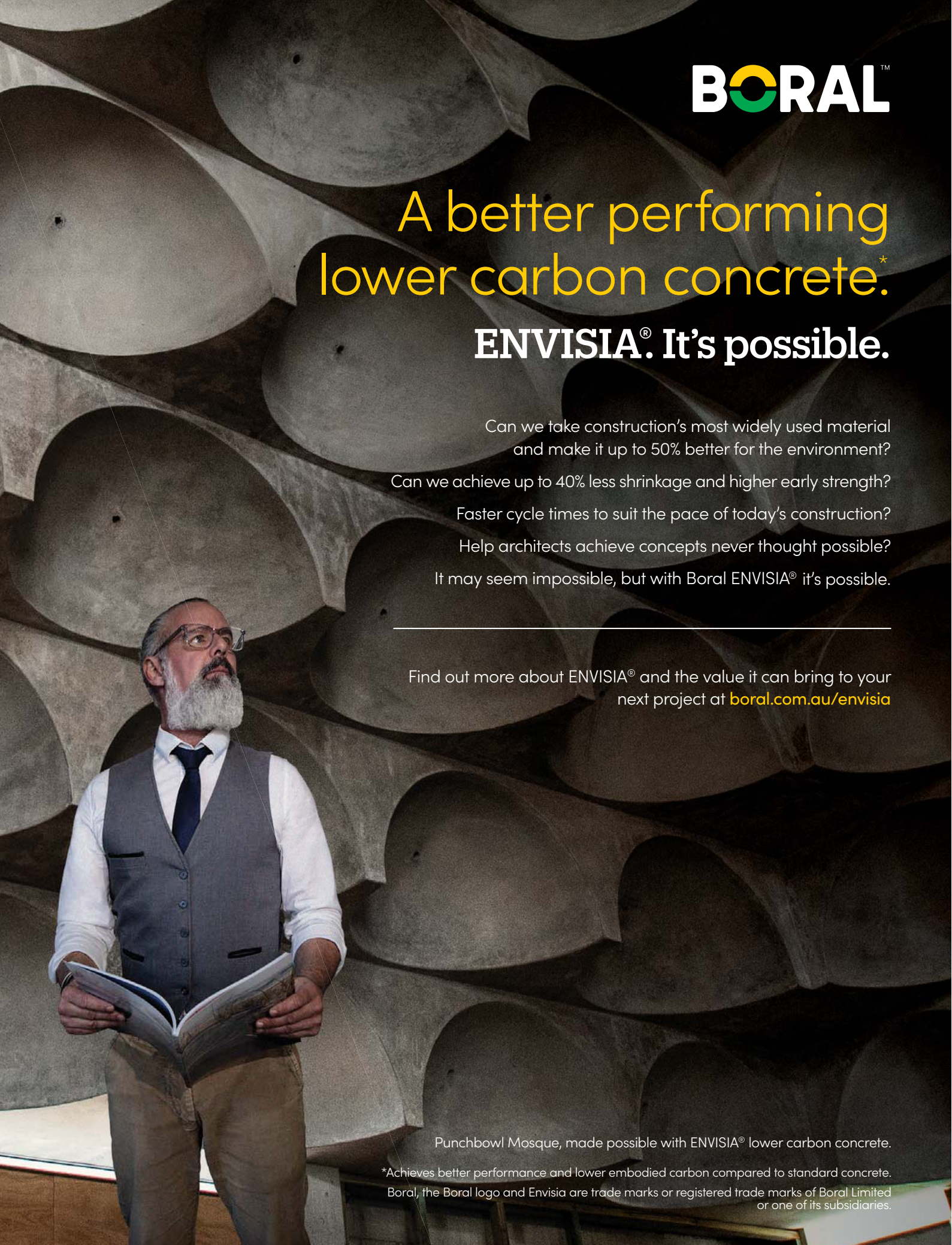
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CONFERENCES & EVENTS | NOVEMBER 2022 - JUNE 2023

09-10 NOV 2022
AUSTRALASIAN STRUCTURAL ENGINEERING CONFERENCE (ASEC)

Location: online and in-person *Melbourne (hybrid)*
Website: *aseconference.org.au*
Celebrating engineering resilience, this biennial conference will explore topics relevant to structural engineers, students, academics, researchers and industry specialists.
Registration open

30-02 NOV-DEC 2022
HYDROLOGY AND WATER RESOURCES SYMPOSIUM (HWRS)

Location: in-person *Brisbane*
Website: *hwrs.com.au*
Join us as we look back at the work and impact of our industry predecessors, discuss current water-related issues and trends, and explore the innovations and technologies that are shaping the future of water engineering.
Registration open

04-09 DEC 2022
INTERNATIONAL CONFERENCE ON COASTAL ENGINEERING (ICCE)

Location: in-person *Sydney*
Website: *icce2022.com*
ICCE promotes academic and technical exchange on coastal-related studies covering a wide range of topics, including coastal waves, near-shore currents, coastal structures, natural hazards and coastal management.
Registration open

27-01 FEB-MAR 2023
AUSTRALIAN INTERNATIONAL AEROSPACE CONGRESS (AIAC20)

Location: in-person *Melbourne* and *Avalon*
Website: *aiac.com.au*
AIAC is the preeminent aerospace forum in the region, incorporating three major conferences focusing on aeronautics, health and usage monitoring, and space engineering, held in conjunction with the Australian International Airshow at Avalon.
Early-bird registration now open

19-21 JUN 2023
CONFERENCE ON RAILWAY EXCELLENCE 2023 (CORE)

Location: in-person *Melbourne*
Website: core2023.org
CORE, the Australasian rail industry's premier technical conference, is celebrating 25 years in motion. The Railway Technical Society of Australasia invites you to submit abstracts for the conference program.
Abstracts close 14 November

22-23 NOVEMBER 2022

Climate Smart Engineering Conference 2022 (CSE22)

Location: in-person at Engineers Australia venues *Melbourne, Sydney, Brisbane and Perth and streamed online (hybrid)*
Website: *eacse.com.au*

CSE22 builds on the success of last year's inaugural conference. An exceptional line-up of national and international speakers will shine a light on projects – exclusive to viewing at this conference. This solution-focused, two half-day event will highlight how the engineering profession can better manage the complex challenges of achieving net zero emissions.
Register at *eacse.com.au*

INTERNATIONAL WOMEN'S DAY

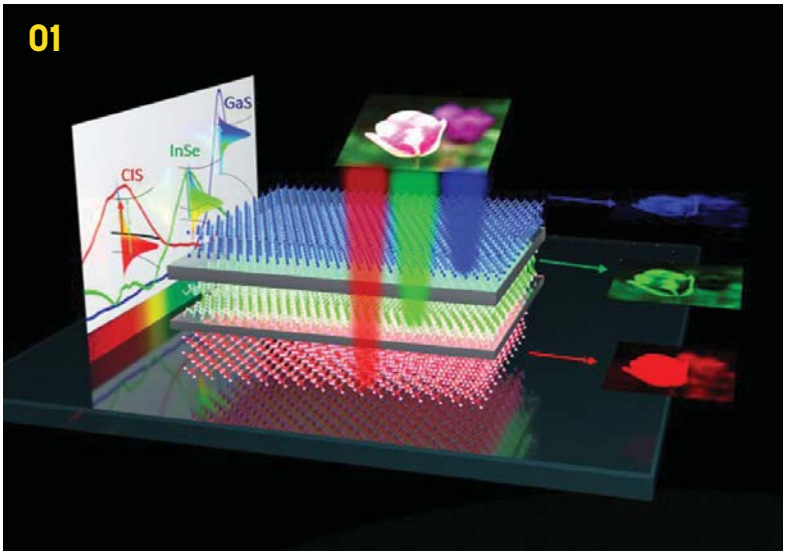
07-09 March 2023

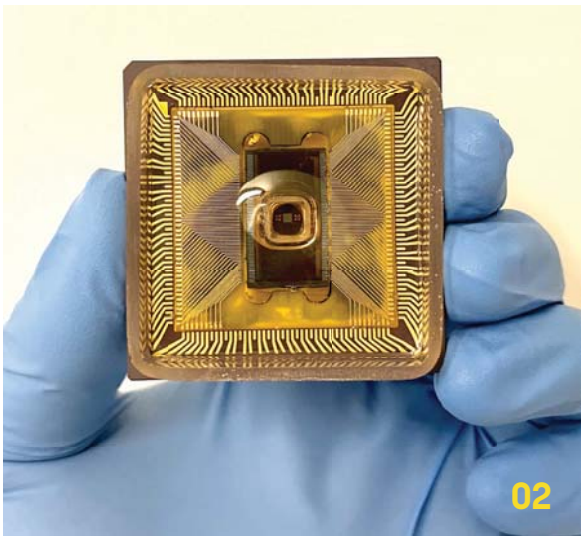
Location: in-person *Sydney, Melbourne, Perth and Brisbane*

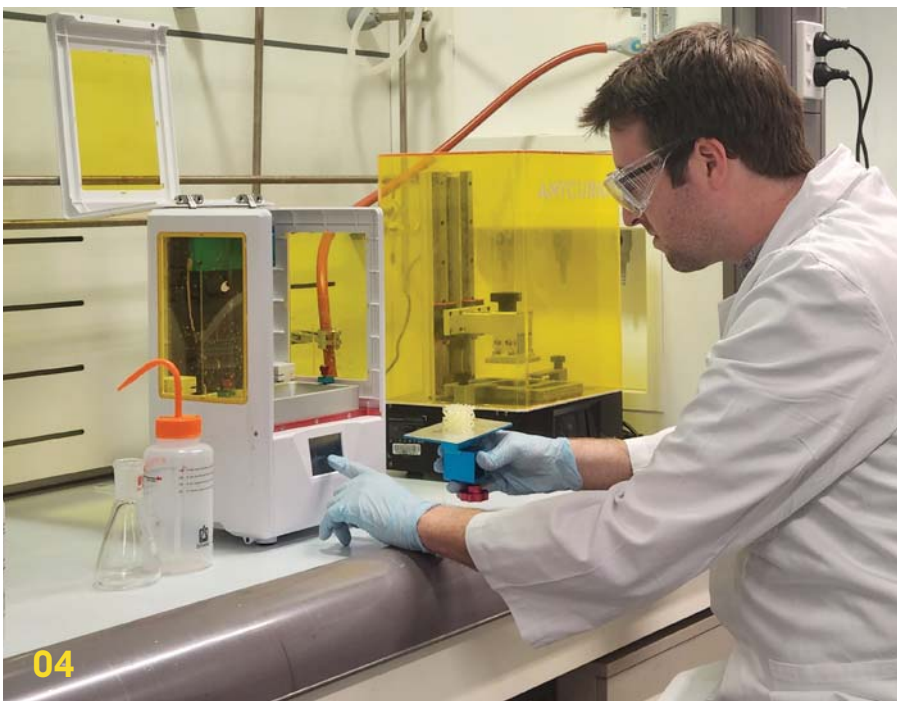
To celebrate International Women's Day, Engineers Australia is excited to introduce our 2023 keynote speaker, Michelle Payne OAM, who joins the long list of inspiring and accomplished female speakers of past years.

Register at *eaiwd.com.au*

THE LATEST DEVELOPMENTS FROM AROUND THE WORLD.







01 Artificial vision

Efficient semiconductors help this artificial vision system to sense different colours. Image: Georgia State University

Engineers at Georgia State University in the US have created a biomimetic artificial vision device that expands colour recognition at a micro-level. Created from a vertical stacking architecture, the designers hope it will one day be used to develop a camera small enough to be used by microrobots. Using van der Waals semiconductors, the stacking system offers greater control, permitting it to sense between red, green and blue hues. "The ultra-thinness, mechanical flexibility and chemical stability of these new semiconductor materials allow us to stack them in arbitrary orders," says Assistant Professor Sidong Lei. "We are actually introducing a three-dimensional integration strategy in contrast to the current planar micro-electronics layout. The higher integration density is the main reason why our device architecture can accelerate the downscaling of cameras." The high-quality colour sensing offered by the device could one day be used to create electronic eyes able to be used by people with vision impairments.

02 Neural net computing

Hundreds of ionic transistors form this ionic circuit. Image: Woo-Bin Jung/Harvard SEAS

Ionic computing is a nascent form of information processing that shifts electrons through liquids rather than the solid semiconductors most electronics use. Inspired by the way the brain stores information, researchers hope to use the different physical and chemical properties of ions to produce improved kinds of computing. Now, Harvard University's John A. Paulson School of Engineering and Applied Sciences has pushed forward the concept by linking individual ionic diodes and transistors into a more complex circuit that could be used for a core process of neural net computing. The system consists of ionic transistors made from concentric ring electrodes in an aqueous solution of quinone molecules, with "gates" that are able to be controlled by fine-tuning pH levels. "While our ionic circuit cannot be as fast or accurate as the digital microprocessors, the electrochemical matrix multiplication in water is charming in its own right, and has a potential to be energy efficient," says electrical engineer Professor Donhee Ham.

03 Cooperative drones

Two drones working in tandem built this two-metre-tall tower out of foam. Image: University College London

A collaboration between Imperial College London and Empa, the Swiss Federal Laboratories of Materials Science and Technology, uses a team of drones to build structures. Inspired by bees and wasps, the system is called Aerial Additive Manufacturing and involves "BuilDrones", which deposit materials, and "ScanDrones", which maintain quality control. "We've proved the concept that drones can work autonomously and in tandem to construct and repair buildings, at least in the lab," says Professor Mirko Kovac. "This scalable solution could help construction and repair in difficult-to-reach areas, like tall buildings." To test the system, the drones were used to construct a two-metre-tall cylinder using a cement-like mixture made of polyurethane-based foam. Assessing the structure in real time and adapting to meet specifications, the drones achieved an accuracy of five millimetres. The system uses a 3D-printing and path-planning framework, which allows drones to adapt to construction needs as the structure takes shape.

04 Printed energy storage

The 3D-printed solid polymer electrolyte can be used as an energy storage device. Image: Dr Nathaniel Corrigan

A University of New South Wales team has developed a 3D-printing process that can create small and intricately detailed energy storage devices. The solid polymer electrolyte (SPE) used in the process is strong and highly conductive, allowing it to be produced in sophisticated geometries without losing the properties that make it useful. Composed of nano-scale ion-conducting channels embedded in a rigid crosslinked polymer matrix, the material can be produced cheaply and may one day find use in medical devices. "One of the other benefits of this SPE in energy storage devices is the fact it increases the cycling stability — that is the number of charging and discharging cycles until its capacity is reduced to a certain amount," says Dr Nathaniel Corrigan. "This material is very stable and has the ability to charge and discharge over thousands of cycles. After 3000 cycles there was only roughly a 10 per cent drop."

Savita DeSouza

CPEng, Technical Director
GHD

SAVITA DESOUZA'S EXPERTISE AS A SYSTEMS ENGINEER HAS GIVEN HER THE OPPORTUNITY TO WORK IN A BROAD VARIETY OF DOMAINS.

DEFENCE, AVIATION, maritime, rail — the list of sectors to which Dr Savita DeSouza has applied her expertise is a long and varied one. As a systems assurance engineer, she's found herself with the opportunity and ability to adapt to any domain.

"The philosophy behind all the activities that we do, the thinking behind it, and even in so much as how we perform those activities, is consistent in its theory," she tells *create*. "Some domains are far more mature than others ... but we learn from each other and it is that application of ideas and application of techniques across different domains, I think, is where my expertise lies."

Flexibility has been a hallmark of DeSouza's career, however, starting out in academia, she moved into consulting: first to defence and then the rail sector.

"I was a senior engineer and I quickly moved into principal engineer, but it was mostly in defence. Then, when I got the opportunity to immigrate to Australia with my husband back in 2010, it was a rail job," she says. "There's so much happening in the railway sector; there's so much yet to come. Billions and billions of dollars' worth of investment that state governments and the federal government is going to make and has made."

DeSouza says she appreciates the formative experience provided by her time in academia.

"Those six years at university — learning from my colleagues, learning from published works and learning from my students as well, who were already people in industry with many years of experience — gave me that solid grounding," she says.

"I can now go and teach others, [coach] junior engineers... on the job and also perform my duties as a fully Chartered engineer."

DeSouza now leads GHD's efforts to grow its systems engineering and assurance capability in Western Australia.

"One of my mandates is to build a team and to build a successful portfolio of projects," she says. "We've got a huge list of clients, and maybe not all of them are now aware as yet that we've got this capability in WA."

As a Chartered engineer, DeSouza appreciates the recognition and credibility provided by the accreditation. And she hopes to maintain the diversity of projects that has characterised her career.

"I've remained in consultancy because of that variety of projects, because of the opportunity to meet clever people," she says. "When you work on such huge projects and you work in a consortium of organisations, it leads to all sorts of different opportunities personally, as well as for the project itself in terms of sharing ideas and learning from each other."

03 TIPS FOR SUCCESS

1 At every opportunity, map out your career and have some goals in mind.

2 Discuss your ambitions with your supervisor.

3 Work hard and persevere: the right attitude and a willingness to learn will take you far.

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The West Gate Bridge Project

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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!

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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.

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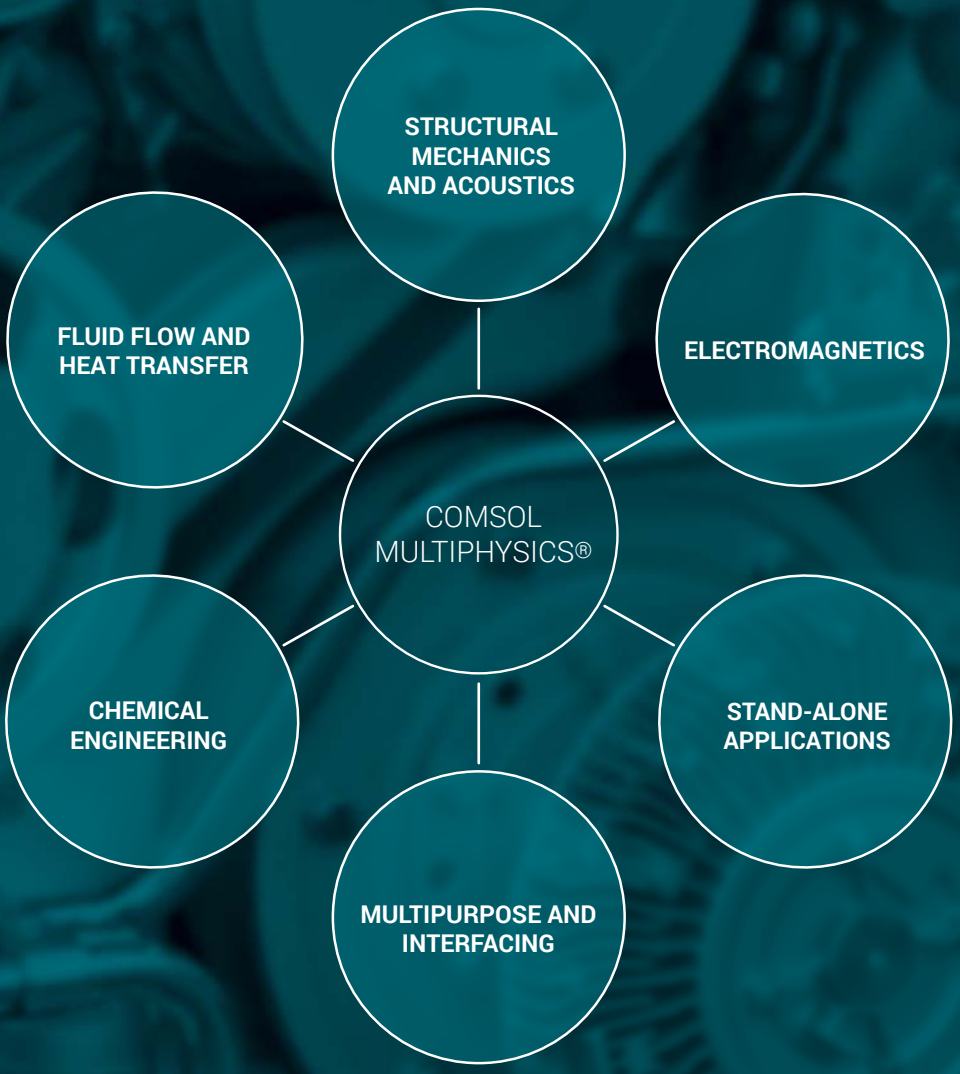

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