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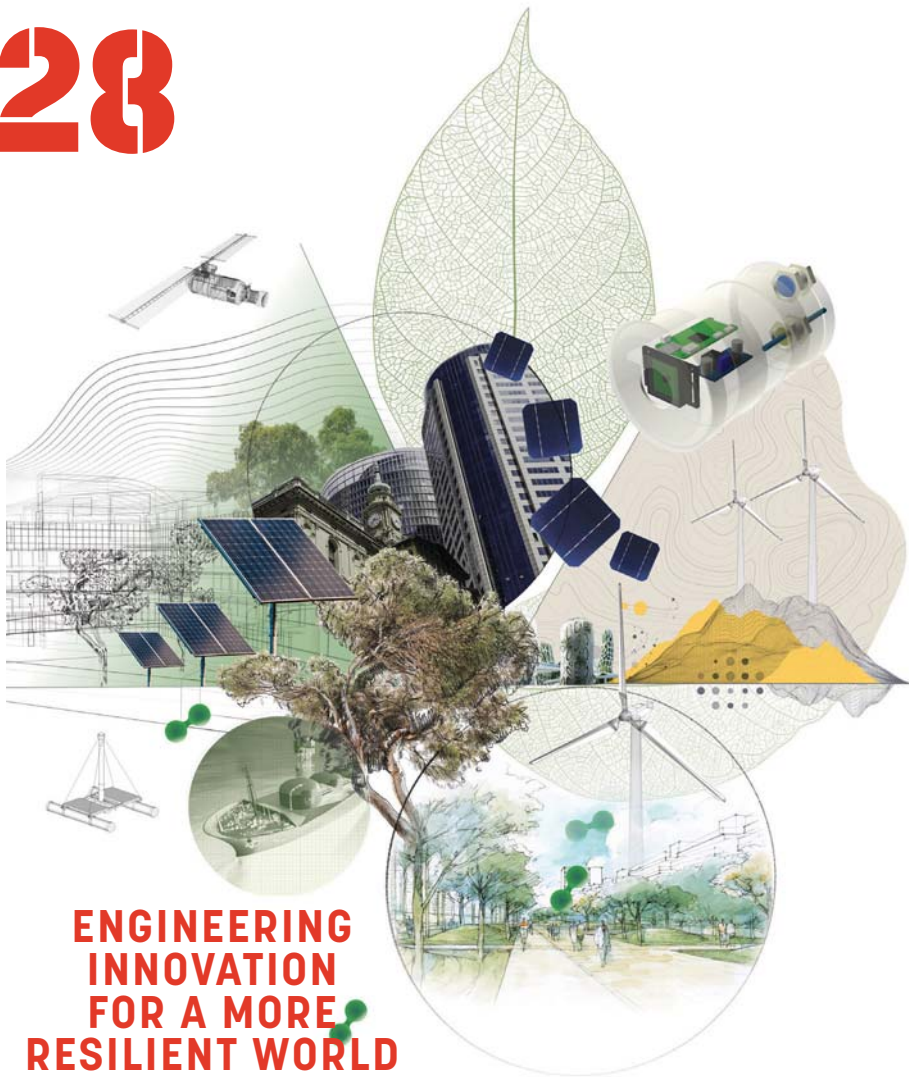
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THE JOURNAL FOR ENGINEERS AUSTRALIA

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28



ENGINEERING INNOVATION FOR A MORE RESILIENT WORLD

World Engineering Day for Sustainable Development offers the chance to celebrate engineers dedicated to finding ways to build a more liveable world.



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IWD
create profiles three women taking a leading role in advancing technological innovation.



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Clean energy and embracing equity

ENGINEERS ARE ADEPT AT TAKING ON THE BIGGEST CHALLENGES AND, THIS MONTH, THE SPOTLIGHT SHINES ON A SUSTAINABLE FUTURE AND GENDER EQUALITY.

Welcome to the March issue of *create*. March is a significant month for engineering, home to both International Women's Day and World Engineering Day.

World Engineering Day, on 4 March, is a celebration of our profession: its ability to advance society and steward efforts to address the most pressing issues facing the world today – namely climate change and the transition to a clean energy economy.

This year's theme is "Engineering innovation for a more resilient world". In this edition we profile five engineers who are using their place in engineering to make change, each in their own way.

At just 14 per cent, female representation in engineering is still too low and we are striving to address this by working with educators to encourage more students, particularly girls, into STEM; supporting STEM returners to foster the re-entry to the industry of women after a career break; and helping employers promote a cultural shift in their organisations for a more diverse engineering workforce.

Engineers Australia is an active member of the Champions of Change Coalition, with a seat at the coalition's STEM group table.

An integral part of membership of the coalition is commitment to transparency and accountability

puts the gender pay gap at 14 per cent across the workforce generally but it's a significantly wider margin of 22 per cent in engineering.

Making engineering more appealing to women will help address the skills shortage in the industry by unlocking the latent talent of half the population. It will also ensure the profession is an accurate representation of the society it serves.

Right now, Australia's aerospace industry is in the spotlight at the Avalon International Air Show, with top flying displays and an expo of industry primes that will bring opportunities for sharing knowledge among some of the profession's finest minds.

After several years of disruption for major events worldwide, it's great to see the event in full swing. You can read more about it in this edition.

"World Engineering Day is an opportunity for us to shine a light on the great potential of our profession to make the world a better place."

From innovation in façade design and sustainable practices to biophilic inspiration in solar panel research and development, World Engineering Day is an opportunity for us to shine a light on the great potential of our profession to make the world a better place.

International Women's Day, on 8 March, has the theme of "Embrace equity". It's an issue Engineers Australia supports entirely for the strengthening qualities equity brings to our profession.

on gender equality initiatives and measures for inclusion.

Engineers Australia shared our actions and progress in the *Champions of Change Coalition Impact Report*, released this month. It's a valuable report that is well worth a read for a snapshot of the practical steps members are taking towards gender equality in their organisations.

To attract and retain women in engineering, closing the gender pay gap and normalising flexible working arrangements must occur. The Workplace Gender Equality Agency



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Flight path

THE AEROSPACE ARENA, HAVING BEEN THROUGH A DIFFICULT FEW YEARS, NOW OFFERS ASTOUNDING INNOVATION, MASSIVE CHALLENGES AND BOUNDLESS OPPORTUNITY IN EQUAL MEASURE.

THE EVE Air Mobility website shows videos of people being ferried through city centres, between skyscrapers and above busy roads in autonomous and piloted electric aircraft.

These drone-type vehicles capable of vertical take-off and landing, Ubers of the sky, will reduce distances between loved ones, the site says. They will be sustainable, accessible, green and silent. They will help us reimagine mobility.

It's easy to assume these air transport offerings are purely fodder for the imagination, a science fiction fantasy.

But that assumption would be incorrect, says Eve Air Mobility's

Head of Product Marketing, Erickson Marques.

In fact, the aircraft are just a few years away from delivery.

"We are aiming to certify our aircraft in 2025, with first deliveries in 2026," Marques says.

"There is a lot of work to do between now and then, and we are following our development process as planned, on schedule.

"We are reimagining mobility, and engineers will play an

incredibly important role, not only in the early stages of the industry, but in its continued growth in the years to come."

The former Chief of the Royal Australian Air Force Air Marshal (Retd) Geoff Brown says the area of UAV/drone technology is a thrilling one right now, mainly thanks to the opportunities it offers.

"Every time I drive on Australian roads, I dream of a better method of getting from ▶

"WE ARE REIMAGINING MOBILITY, AND ENGINEERS WILL PLAY AN INCREDIBLY IMPORTANT ROLE NOT ONLY IN THE EARLY STAGES OF THE INDUSTRY, BUT IN ITS CONTINUED GROWTH IN THE YEARS TO COME."





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“THE VERY EXCITING STUFF – BUT EQUALLY A VULNERABILITY – IS ABOUT AEROSPACE NOT BEING JUST ABOUT PLATFORMS. IT WILL BE ABOUT THE INTEGRATION OF THOSE PLATFORMS.”

A to B,” he says. “How much less road infrastructure do we need to maintain if we can have these small highways in the sky?”

“The engineering is coming close to making this real. It’s just that we also need a shift in acceptance of autonomous aircraft as a mode of transport. That will be a big leap for humans before that trust is built.”

This concept of urban air mobility (UAM), a sector Marques calls “a birthplace for new ideas and solutions”, is one of the many ideas, technologies and systems that will be discussed and demonstrated at the upcoming Avalon International Airshow/Aerospace and Defence Exposition and the Australian International Aerospace Congress.

“Avalon is a great showcase for Australian industry and Australian innovation,” Brown says. “It highlights a lot of the great

work going on in research and development in this country.”

One of the major challenges in the drive towards UAM – and numerous other aerospace innovations – is a lack of engineers available to design and develop relevant technologies and systems.

“Aviation is in a perfect storm,” says Peter Marosszeky, a professional aircraft engineer and almost 50-year veteran of the Royal Aeronautical Society.

“There is a shortage of pilots and engineers and a lack of experience and training. This is partly due to the ageing workforce, which is a monumental issue. Education levels and the number of new-entry pilots and engineers is an issue we really need to discuss very carefully.”

Eve Air Mobility is working its way around what Marques says are “numerous challenges in the design, engineering and

manufacturing of these aircraft” by making the most of its relationship with parent company Embraer, the world’s third largest aircraft manufacturer.

“We are able to really benefit from Embraer’s engineering and also its experience in successfully certifying aircraft around the world,” he says. “That is a major advantage as we progress.

“As we continue the path toward certification and entry into service, we are also carefully and thoughtfully developing a suite of services including air traffic management systems. Our approach is to not just build a sustainable, safe and reliable aircraft; we also see the need to

develop the entire ecosystem so that these aircraft, when certified, are ready to fly.”

Brown says one technology likely to have a massive impact on reducing the cost of aircraft maintenance is 3D printing.

“If you can manufacture a part on a 3D printer, you could save a lot of a lot of money in terms of logistics and a lot of downtime for aircraft,” he says.

“A big issue will be the ability to certify that 3D manufacturing. But once we solve that particular problem, all of a sudden we can cut or reduce costs significantly.”

Chris Deeble, Deputy Secretary of the Capability Acquisition and Sustainment Group in the Australian Government’s Department of Defence, agrees that one of the most intriguing challenges for those in the aerospace arena is the integration of various previously standalone platforms. ▶

ABOVE: The Avalon Airshow, last held in 2019, returns this year.

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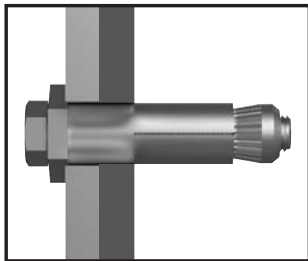
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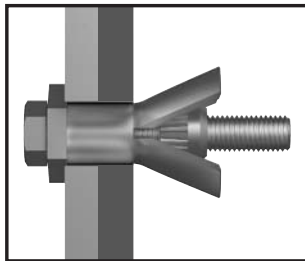
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“The very exciting stuff – but equally a vulnerability as we’re moving forward – is about aerospace not being just about platforms anymore. It will be about the integration of those platforms, and the way data is utilised to be smarter in assisting decision-making,” says Deeble, who is also ex-Chief Executive of Northrop Grumman Australia and a 37-year veteran of the Australian Defence Force.

Deeble, who played pivotal roles in such defence projects as the Wedgetail program, the Collins-class submarine program and the Joint Strike Fighter program, says artificial intelligence and machine learning will play important roles in helping humans make faster and better decisions in the aerospace arena.

This is just as relevant in the civil arena as it is on the battlefield. After all, Eve Air Mobility’s aircraft won’t be able to be controlled via a sandboxed system that ignores everything else going on in the city.

“You’ll still need platforms, but the integration of the platforms, plus the integration of these other technologies will help you observe, decide and act at speed,” Deeble says. “In some cases ... a human making a decision will take too long. An example of that might be hypersonics. When you talk about something travelling at up to 10,000 to 14,000 km an hour, the human reaction will potentially have to be automated.”

Ensuring artificial intelligence and machine learning integrate data from all sources, as well as supporting prediction and decision-making with appropriate

“IN SOME CASES, A HUMAN MAKING A DECISION WILL TAKE TOO LONG. WHEN YOU TALK ABOUT SOMETHING TRAVELING AT UP TO 10,000 TO 14,000 KM AN HOUR, THE HUMAN REACTION WILL POTENTIALLY HAVE TO BE AUTOMATED.”

human interaction and enabling action at speed across a multi-domain environment will require engineers to adopt a new outlook on the way systems are developed, architected and evolved.

“How do you change the paradigm of thinking about domains in air, land and sea, to now thinking about air, land and sea – surface and sub-surface – space and cyber?” he asks.

“Bringing that together will be challenging but is also the very exciting part of delivering defence capability into the future that will ... likely leverage its advantages into commercial technology in ways we haven’t seen before.”

In such a fast-changing environment of technology, systems and innovation, according to Marques, opportunities now exist for nearly every type of engineer.

“Whether aerospace, electrical, civil, data or industrial, all will play a role,” he says. “Outside of just the aircraft and their operation, when you consider the need for new vertiports for takeoff and landing

Turbulent times

According to The Royal Aeronautical Society’s Peter Marosszeky, a major issue facing the aerospace sector is the talent drought. But that’s not the only one.

Also troubling the sector, he says, are these problems:

- Inability of airline operators to restore aircraft that were put in storage, because of the lack of engineers and the prohibitive costs.
- Cost of aircraft storage, both actual and opportunity costs.
- New aircraft with new technologies come with costs that are beyond the reach of most carriers, which are already burdened with existing lease costs.
- Prohibitive costs associated with the re-training of pilots and engineers, and with upgrading training programs to accommodate new technologies.
- Increasing regulatory standards around the training of technicians, pilots and engineers.
- Increasing pressure from regulators and industry for operators to improve technology development.
- Shortage of approved maintenance, repair and overhaul facilities.

“[Research and development] in new technologies is advancing at a rapid rate,” Marosszeky says.

“Those changes and advances in technology are superb.

“But keeping abreast of these changes is a major challenge for the operators, and for the pilots and engineers. Aviation is a technically challenging, expensive business.”

in cities around the world, there are all types of opportunities not only with a manufacturer, but with the industries that will support operation of eVTOLs in the future.

“We are seeing a lot of interest from engineers who want to be a part of creating something totally new ... It’s exciting, leading-edge kind of work.” ●

CHRIS SHEEDY

WORDS BY ROMILLY MADEW AO AND DR BRONWYN EVANS AM

TIME TO ACT

THE THEME FOR INTERNATIONAL WOMEN'S DAY 2023 IS #EMBRACEEQUITY, AND ENGINEERING CHANGE WILL PLAY A VITAL PART.

AS WE mark International Women's Day 2023 this month, it's timely to call out a crisis that needs a strong and swift response.

There continues to be a lot of talk about our skills deficit, but in the engineering sector we have lurched from shortfalls to an alarming 41 per cent increase in engineering vacancies over the past 12 months alone.

The profession has more than a skills problem. It's in the grip of a gaping vacancies black hole compounded by COVID-19 and border closures.

This is more shocking when examined in a context that still shows just 14 per cent of working engineers across the nation are women. This statistic has not budged much in decades.

As the academic year is under way in universities across the country, it is sobering to note that Australia has the dubious ranking of recording the second-lowest proportion of engineering

LEFT: Engineers Australia CEO Romilly Madew AO.

graduates compared to other disciplines among OECD countries. Of these graduates, only 17 per cent are women.

That number is even more alarming when we know the nation is simply not keeping up with the need for STEM skills and the serious challenges this presents in an increasingly digital interconnected world.

The federal Department of Education reports that the number of school students studying STEM in years 11 and 12 has flatlined at about 10 per cent or less.

MAXIMISING POTENTIAL

It is stating the obvious that society is made up of roughly 50 per cent females.

We must harness the engineering skills of 100 per cent of our population – not just the male half – if we are to make any inroad towards meeting Australia's urgent need for more qualified engineers.

Engineering is the biggest employer of the STEM professions and the worst performer for female participation.

Engineers Australia's *Women in Engineering* report is confronting reading on that score.

Findings show the gender gap begins early, and the biggest reason girls don't choose to study engineering is that they continue to simply not know what engineering is and what engineers do.

Other barriers include concerns around not being good enough at maths and physics, perceptions of engineering as too male-dominated, challenging or boring; and not feeling supported in STEM subjects from as early as primary school.

For girls who become one of the handful of women who

do pursue an engineering career, the research found that they experienced the work as meaningful and impactful.

On the flip side, women also reported leaving the profession because of a lack of visibility and limited career opportunities.

This is not good enough.

AN URGENT ISSUE

The profession must uniformly act to address the pay gap, parental leave and flexible work.

But more can and must be done, including setting strong targets for gender representation.

“WE MUST HARNESS THE ENGINEERING SKILLS OF 100 PER CENT OF OUR POPULATION – NOT JUST THE MALE HALF – IF WE ARE TO MAKE ANY INROAD TOWARDS MEETING THE URGENT NEED FOR MORE QUALIFIED ENGINEERS.”

RIGHT: Dr Bronwyn Evans AM, Chair Building 4.0 CRC (left), and Romilly Madew AO at the 2022 Engineers Australia Excellence Awards.



To increase the visibility of the profession among girls and young women, we also need a national and long-term response from our political leaders.

Decades ago, they galvanised to establish the Australian Institute of Sport in a serious investment and commitment to improving our medal targets off the back of headlines shaming us for our performance following the 1976 Montreal Olympics.

What about the urgent national issue of Australia needing more engineers – and therefore more women in engineering – to help address a significant chunk of our skills crisis?

We welcome Industry and Science Minister Ed Husic's announcement of an independent expert review panel for the Pathway to Diversity in STEM review.

This is part of the Australian Government's commitment to boost diversity and increase the participation of women in Australia's STEM sectors.

However, we need to move faster around engineering and ensure that all levels of government work together as a matter of urgency to address this imbalance.

Actions should include increasing Australia's teaching capability in STEM and giving engineers a seat at the policy table to guide and guarantee that the engineering skills perspective is incorporated into decisions and planning.

Shifting the dial on diversity in engineering requires a holistic and coordinated approach. To ignore it will be at the nation's peril.

#EmbraceEquity

—
Romilly Madew AO is CEO of Engineers Australia. Dr Bronwyn Evans AM is the former CEO of Engineers Australia and Chair of Building 4.0 CRC.





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WORDS BY MICHELLE WHEELER

MAKING HER MARK

THREE EXCEPTIONAL ENGINEERS ARE FORGING AUSTRALIA'S FUTURE IN HUMAN-CENTRIC TECHNOLOGY, RENEWABLE ENERGY AND SPACE EXPLORATION.

LIKE MANY space engineers, Katherine Bennell-Pegg's lifetime passion started with a childhood dream of becoming an astronaut. Unlike most of her colleagues, Bennell-Pegg came achingly close to achieving it.

Bennell-Pegg is a Director of Space Technology at the Australian Space Agency, leading the agency's Access to Space and Human Spaceflight programs. Last year, she beat 22,523 hopefuls to become one of 23 people considered as potential astronauts for the European Space Agency.

While not ultimately selected, Bennell-Pegg says it was an "incredibly fantastic" experience.

"Having the chance to actually apply was a thrill in itself,

"HAVING THE CHANCE TO ACTUALLY APPLY WAS A THRILL IN ITSELF – KNOWING THAT I'D EVEN MET THE MINIMUM CRITERIA."

knowing that I'd even met the minimum criteria," she says.

"And then progressing through each stage just brought with it a new level of impostor syndrome and awe in the amazing community of people around you that are also applying."

Since graduating from the University of Sydney in 2007, Bennell-Pegg has worked on international space missions in Europe, the UK and the US. She returned home three years ago to guide the advancement of Australia's space capability over the next decade.

Bennell-Pegg oversees the Australian Space Agency's roadmap for access to space, including launch and returns, satellite infrastructure, and how to move around in space once you're up there.

LEFT:
Dr Fiona Kerr,
NeuroTech
Institute.

"We also look at ... access for Australian organisations to places like the International Space Station or lunar facilities or what may happen over the following years for new destinations," she says.

WIRED TO CONNECT

While Bennell-Pegg has her eyes on space, complex systems engineer Dr Fiona Kerr believes we still have a lot to learn about how incredible humans are.

The founder and Chief Executive of the NeuroTech Institute, Kerr has worked as an anthropologist, a psychologist, a mediator, a cognitive scientist and an engineer. She says we're all "electrochemical bags of sensors" built to connect.

"When we're face-to-face, we have a number of things [that

happen] because we are in direct proximity," Kerr says.

Eye contact gets our neurons firing, making parts of the brain "stand up".

"We also have thousands of chemicals that we are swapping, that change the way that our brains work," Kerr says.

"We have interpersonal neural synchronisation."

Kerr has worked with artists, technologists, economists, soldiers and nurses, and in organisations ranging from the Department of Defence to Cirque du Soleil.

What they all have in common, Kerr says, is a need for complex problem solving and decisions.

She says cross-collaboration and brain synchronisation leads to better decision-making, something she was able to demonstrate in a 2021 study.

"In the control group, a person tackled a complex problem over a technological interface, and in the trial group strangers collaborated face-to-face," Kerr says.

"One of them then tackled the complex problem via the technology. Each participant who had collaborated in-person learned faster, applied the knowledge longer, and scored better. We really can make each other smarter through that extra ▶



RIGHT (from top): Katherine Bennell-Pegg, Australian Space Agency; Bennell-Pegg with a University of Sydney Rocketry Team.



physiological and neurobiological activity that occurs when we are with each other.”

Kerr has also studied how leaders change our brains – for better or for worse. She says leaders of adaptive organisations tend to be complex thinkers who understand the importance of a strong vision and clear values.

“Without that, people won’t step into unknown environments,” she says.

Kerr believes engineers have a responsibility to think carefully about what they’re trying to achieve, and actively push back against technological optimism or “shiny ball syndrome”.

“What I’d love is for engineers to think more widely about the problems they can solve, and about the questions they can ask,” she says.

“When we ask a good question, then as engineers, we make brilliant technology. When we just allow profit to steer us towards things like sticky screens ... technology is just as good at that, but we don’t build a better world.”

FUTURE FUEL

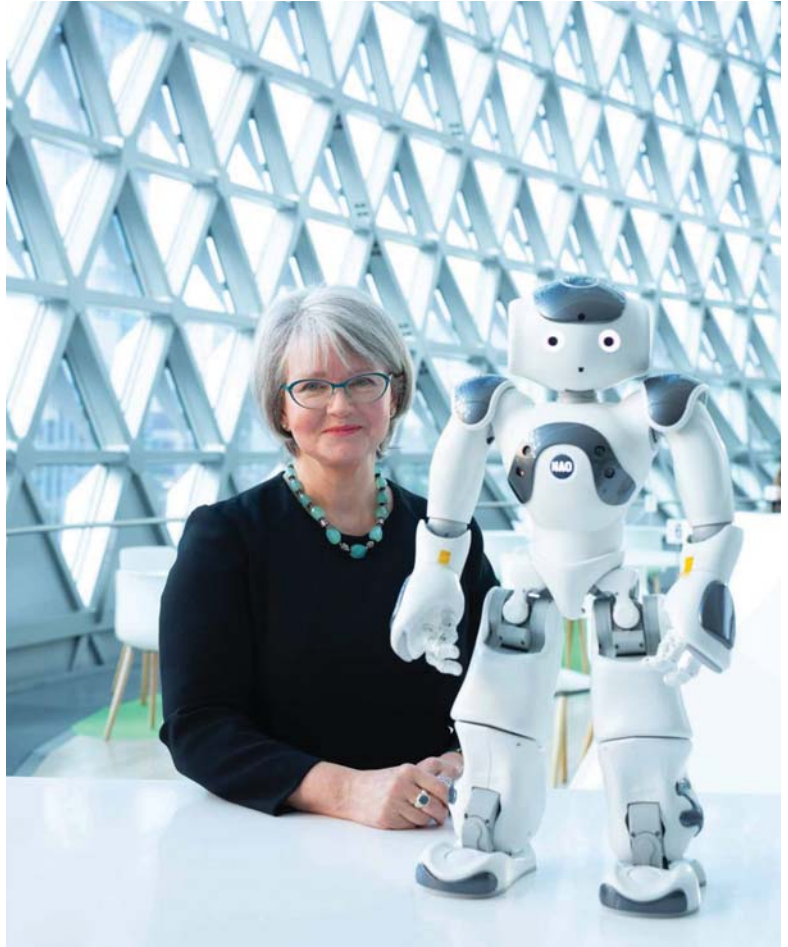
Biofuels researcher Dr Morley Muse is making brilliant technology with her work turning wastewater into energy.

Her PhD research focused on breaking down microalgae from wastewater using enzymes and bacteria, producing biogas and electricity through anaerobic digestion in the process.

Muse is now investigating the production of hydrogen from biogas obtained through anaerobic digestion, as well as directly from wastewater systems.

Muse grew up in southern Nigeria, a part of the world known for its crude oil production. It was there, on a science excursion to an oil company in the Niger Delta as a 14-year-old, that she found her passion for renewables.

The students were taught about oil spills and invited to think creatively about ways to solve the problem.



“WE REALLY CAN MAKE EACH OTHER SMARTER THROUGH THAT EXTRA PHYSIOLOGICAL AND NEUROBIOLOGICAL ACTIVITY THAT OCCURS WHEN WE ARE WITH EACH OTHER.”



ABOVE: Kerr’s research emphasises the advantage human contact can have over robot interactions.
LEFT: Dr Morley Muse, iSTEM Co.

“I’ve seen first-hand the adverse effects of oil spillage,” Muse says.

“That’s really what worried me, and that led me to start looking into alternative forms of energy.”

Muse, a chemical and environmental engineer, found a way to break down the tough cell walls of the algae using enzymes and bacteria. This increased volatile fatty acids production by more than 70 per cent, further increasing biogas production.

“I’m one of those people that if there’s a problem, I try to fix it,” Muse says. ▶



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“If I can’t fix it, I don’t talk about it.”

It’s an approach Muse has also taken to boost the representation of women in engineering. She sits on the board of Women in STEMM Australia and was an ambassador for CSIRO’s Innovation Catalyst Global program, working to connect female STEM academics to industry partners.

But her biggest leap came after she read a 2020 report into Australia’s STEM workforce from the Office of the Chief Scientist.

“When I saw those statistics, I thought that it would have been a state of emergency, considering the current STEM skills shortage,” she says.

The report found only 29 per cent of the university-qualified STEM workforce and 15 per cent of employed university-qualified engineers were women.

“What was more interesting was that 56 per cent of university-qualified females in STEM in Australia are Australian women born overseas,” Muse says.

“I’VE SEEN FIRST-HAND THE ADVERSE EFFECTS OF OIL SPILLAGE. THAT’S REALLY WHAT WORRIED ME, AND THAT LED ME TO START LOOKING INTO ALTERNATIVE FORMS OF ENERGY.”

ABOVE:
Muse was inspired to work in renewables after visiting an oil refinery in Nigeria.

“But they experienced over four times higher unemployment. I thought that was a fundamental problem.”

Shocked by the research, Muse quit her job. She connected with data scientist Dr Ruwangi Fernando and together they founded iSTEM Co.

It’s a research, consulting and talent-sourcing company that facilitates employment for women, including women of colour and women from culturally and linguistically diverse backgrounds.

With a database of more than 10,000 women, iSTEM Co. is launching a “tryout to recruit” program that will place women

in companies for six weeks, 12 weeks or six months.

“Afterwards, if you like them, you keep them,” Muse says.

“We are actually building a new platform to facilitate this and enable employers to easily and readily find women in the STEM workforce.”

Women in the program will also receive mentoring for up to a year.

STATE OF THE NATION

Bennell-Pegg, Kerr and Muse all see big opportunities for Australian engineers in the future.

Muse believes Australia can be a leader in co-generation strategies and renewable energy.

“We are a very strong economy in the Asia region, so we can quickly become the alternative ▶

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energy giant if we embrace this," she says.

Kerr wants engineers to be proactive enough to shape what the country does with technology and where it's going.

Don't start with the "shiny bauble" that's being sold to you, she says. Instead, engineers should think about what they're actually trying to achieve.

Kerr says development of robot nurses, for instance, can overlook the uniqueness of non-technical interactions. She says a human nurse can completely change a patient's physiology in three to five minutes.

Something as simple as looking into a patient's eyes and patting their hand can have a huge impact, Kerr says.



"RIGHT NOW, THE WORLD'S ON THE CUSP OF THE NEXT SPACE EXPLORATION AND SPACE INDUSTRIALISATION ENDEAVOUR. AUSTRALIA NOW IS CAPABLE ENOUGH TO BE PART OF THAT."

"It lowers your cortisol, lowers your adrenaline," she says.

"It also changes the way your hippocampus is firing; it starts your cortisol receptors taking cortisol out of your bloodstream. And the nice thing is it's cyclic."

Bennell-Pegg says Australia is a unique place for engineers in the space industry.

"It's quite a nascent sector, but there's so much potential for the industry to develop and mature rapidly over the coming years," she says.

"That's not an opportunity many space engineers around the world get."

Australia has a lot to offer the international space community, from clear skies and remote lands to technical expertise in areas like optical communications and field robotics.

The Australian Space Agency is also supporting NASA's Artemis missions to the Moon.

"Right now, the world's on the cusp of the next space exploration and space industrialisation endeavour," Bennell-Pegg says. "A lot of the world is going back to the Moon and Australia now is capable enough to be part of that."

Engineering is at the core of new missions, Bennell-Pegg says.

"It's what enables us to solve big scientific questions that scientists pose that can only be solved from space," she says. "And it's what helps us to create the technologies that didn't exist when those questions were asked." ●

ABOVE:
NASA builds a sounding rocket range in the Northern Territory.

—
International Women's Day is observed around the world each year on 8 March. The theme for International Women's Day 2023 is "#EmbraceEquity".

Bursting the bubble

Australia is in some ways a late entrant in the space race. But Katherine Bennell-Pegg, who has experience at NASA, the European Space Agency and Airbus, says that does come with some advantages.

"We have the opportunity to emerge tailored for this more commercial or NewSpace-type activity around the world," she says.

"Whereas a lot of other space industries are having to turn the ship and adapt across."

Because Australia is still establishing its space workforce, it must draw from other industries where it has great technical expertise, Bennell-Pegg says. That means there is a lot of potential for innovation.

"When I was working overseas, it was very, very hard to enter the space industry as an engineer," Bennell-Pegg says.

"Very few people leave and there are very few opportunities for new entrants, say at mid-career or later, so you're really in a bubble.

"In Australia, you're not in a bubble. And that, I think, is really special."

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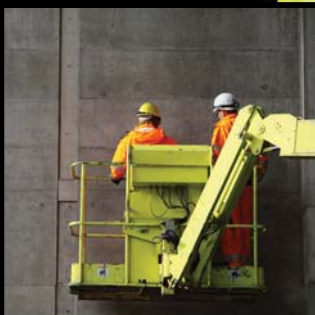
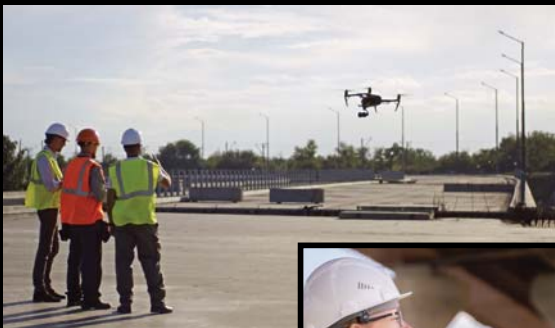
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THINKING AHEAD

WORDS BY CHRIS SHEEDY

AS THIS YEAR'S WORLD ENGINEERING DAY FOCUSES ON SUSTAINABILITY, WE SHINE A SPOTLIGHT ON ENGINEERS WHO LEAD WITH INNOVATION, TRANSFORMATION, COLLABORATION AND PASSION.

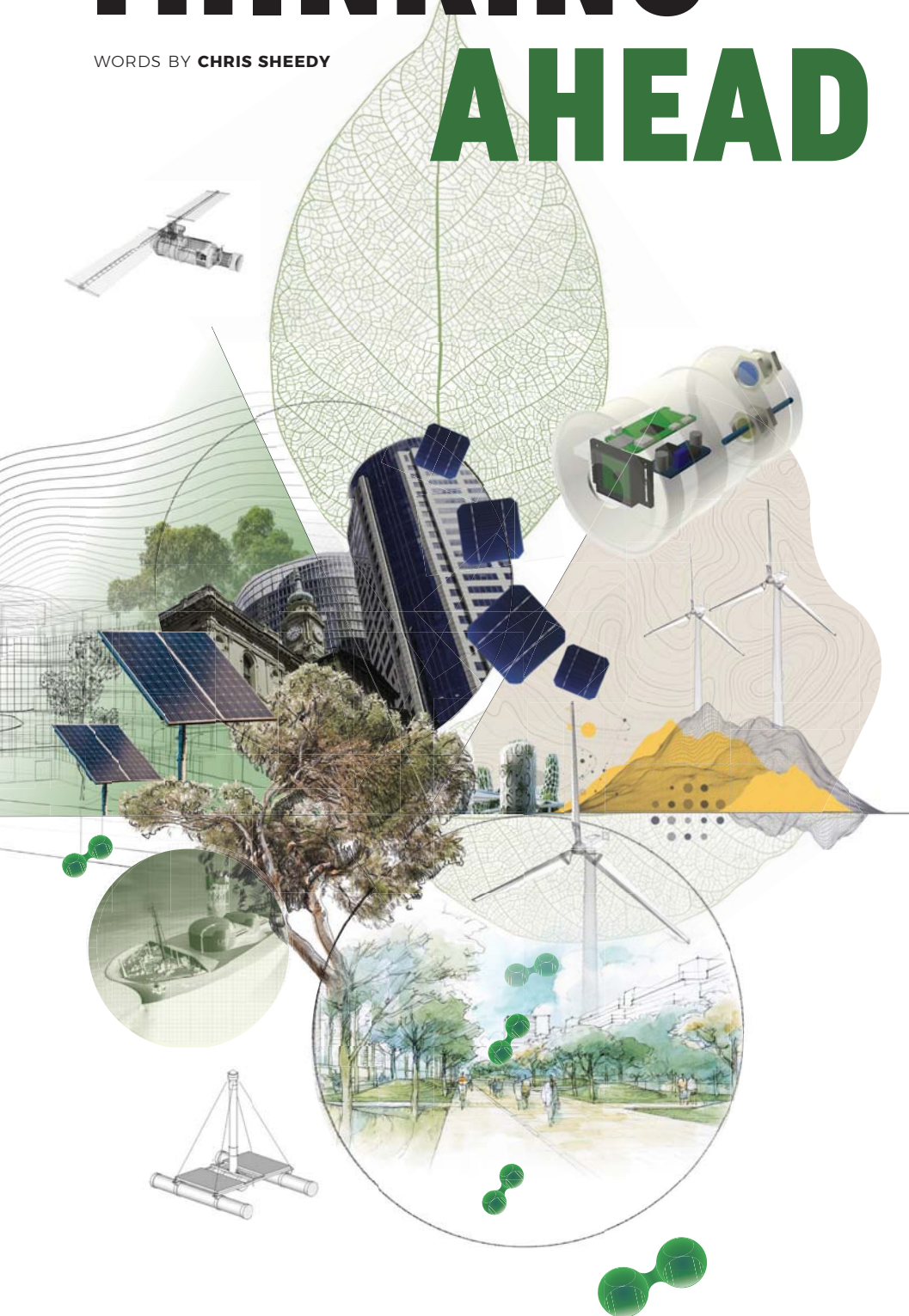
IN THE Australian engineering profession, you don't need to look far to find examples of excellence and innovation in sustainable practices, processes, products and outcomes.

To address climate change, one of the greatest challenges of our time, engineers must be at the centre of every solution. Across sectors, including construction, renewable energy, urban design, ocean management, conservation and more, engineers are responding to the call.

This vital role is celebrated annually on 4 March as World Engineering Day for Sustainable Development. The theme for this year is "Engineering innovation for a more resilient future".

"It provides an opportunity for us to reflect on the critical role that engineers play in shaping our world for current and future generations," says Engineers Australia Chief Engineer Jane MacMaster. "In Australia, engineering has been instrumental in shaping our cities, infrastructure, and industries and has helped us to overcome some of the challenges and pursue some of the opportunities that come with living in a vast and diverse country.

"From building the iconic Sydney Harbour Bridge to developing cutting-edge technologies for renewable energy, engineers have played a critical role in shaping the nation.



Australian engineers have brought new technologies to the world, from Wi-Fi and bionic ears to software and aerospace systems.”

MacMaster says the complex and interconnected sustainability challenges facing the world will require engineering solutions at an unprecedented pace and scale.

“To ensure that engineering continues to play a crucial role in shaping a more circular and sustainable economy and a more equitable world for all, it’s important that we support the engineering community,” she says.

“This includes investing in engineering education and research, promoting diversity and inclusion in the profession, and encouraging the next generation of engineers to pursue their passions and make a positive impact on the world.”

For this year’s World Engineering Day for Sustainable Development, *create* profiles five engineers using their knowledge and experience to protect and improve the world we live in.



ABOVE: Jane MacMaster, Chief Engineer, Engineers Australia. **BELOW:** Paul Easingwood (centre), Bligh Tanner.

adding real value,” he says. “How can we adapt and reuse, feeding into the sustainability consideration? What can we do to ensure the building is worth a lot more in the future?”

Easingwood and his team at Bligh Tanner are currently asking those questions of the team managing the rejuvenation of Brisbane’s Blue Tower and Gold Tower, both for Marquette Properties.

“We’re going through the process of how do they add value,” Easingwood says.

“These are \$300 to \$400 million assets, and the owners are going to spend \$20 million or more on them. Done right, in five years they will have improved their asset value well beyond that.”

Easingwood has recently completed a major project at No1 Anzac Square in Brisbane, as part of the development team for AsheMorgan.

Three buildings were brought together into a single office precinct, united by an impressive glass atrium, 6000 plants, two trees, large-format marble floors, 180 m² of green walls and high-class end-of-trip facilities.

Most importantly, as the atrium and facilities were significantly upgraded and an entire city block was transformed, as much of the existing buildings as possible was kept original.

“The mechanical systems largely remained unaltered,” he says. “The large amount of concrete volume that constitutes the structural frame remained, apart from small pieces we cut out here and there to add new sections. That concrete was recycled offsite.”

By stripping off certain elements and modernising and refreshing facilities that appeal to the end user, there’s no need to dig holes in the ground, take away truckloads of dirt, or pump tons of concrete.

“That makes it a special sort of project, the sort of project we really enjoy working on,” Easingwood says.

The idea of greater use of engineered timber in buildings, as is becoming increasingly common in Europe, also excites Easingwood. ▶

ADDING VALUE TO BUILDINGS

Paul Easingwood

Director Structures and Façades, Bligh Tanner

When Paul Easingwood CPEng FIEAust is brought on to a structural or façade-related project, it’s often at a time that the building is reaching the end of its design life.

A less inspired engineer might suggest a lick of paint, a new façade to hide the blemishes, or a basic renovation of the interior spaces.

Easingwood prefers a more thoughtful, holistic and sustainable approach.

“It’s really about trying to be smart about how we can rejuvenate the building whilst

“AS ENGINEERS, WE GO THROUGH A LOT OF TRAINING. WE’RE PROBLEM-SOLVERS FUNDAMENTALLY, AND WE CAN ADD VALUE TO CLIENTS.”



An engineered timber annex building at the ground level of a rejuvenated building can completely transform that building and its surrounds, he says.

“It can turn a building into a real showpiece,” he says. “That type of development, with an energy efficient, high green-star rating, can turn an older building into a front-cover-of-a-brochure kind of release.”

Having the confidence to make such suggestions to a client, to stamp his authority on a building rejuvenation project, is what motivates Easingwood.

“I always had a very strong interest in not being subservient to the architect or subservient to the client and saying, ‘Yes sir, we’ll design a steel frame because that’s what you’ve asked for,’” he says.

“As engineers, we go through a lot of training. We’re problem-solvers fundamentally, and we can add value to clients.”

DESIGNING A SOLAR FUTURE

Jefferson Lam

PhD student, Monash University

WHETHER HE’S surfing, hiking, camping or picnicking with friends, Jefferson Lam loves being outside. Now, preserving the environment he enjoys so much drives his career choices.

Lam is in the first year of a PhD focusing on developing the next generation of solar panels.

“There are lots of people researching ways to maximise efficiencies, stabilities and scalability,” he says.

“But solar panels are not just this wafer or cell that absorbs light and converts it into energy; they need protection from the external environment.

“My research looks at the whole panel. Solar cells need to be protected in encapsulation materials so that they can survive harsh outdoor conditions and extreme weather events. As a

materials engineer, I’m trying to work with mixes of different materials – known as composite materials – to improve this encapsulation.”

Why is this important? Encapsulation materials play a significant role in the durability, lifespan and

recyclability of the panel, Lam says. Most solar panels currently use a design that is decades old, limiting flexibility, accessibility and recyclability.

“More and more we are beginning to realise that maybe this isn’t the formula: having thick, heavy glass covers; poorly recyclable glue; or a back sheet that contains fluoropolymers. These components are outdated,” he explains.

Lam’s inspiration for new encapsulation design, perhaps unsurprisingly, comes from nature.

“What does nature do to create super-sustainable, recyclable, modular solar harvesting components?” he asks.

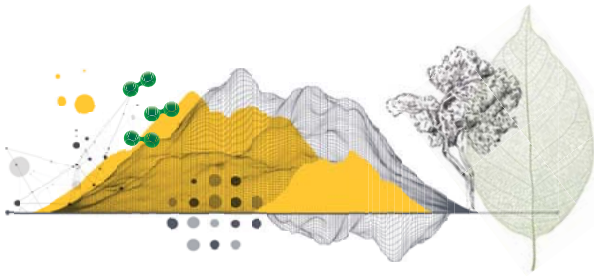
“The answer is right there in plant leaves. They need to be efficient harvesters of light. They

“THE WORLD IS A VERY BEAUTIFUL PLACE AND I WANT TO HELP TO PRESERVE THAT.”



BELOW: Jefferson Lam studies for a PhD at Monash University.





can't be dirty and are self-cleaning. They must control the amount of moisture getting in, repel predators, shield their cells from UV light and more.

"So, what I'm doing in this first part of my thesis is looking at the top layer of leaves, the cuticle, to see what properties can be applied to solar panels to improve lifespan and address the three killers of solar panels: humidity, UV light and temperature."

An important consideration is to enable a new, more efficient manufacturing process.

Current processes require the production of one panel at a time, as each must be encapsulated individually.

"I envision a future where we have rolls of encapsulant and rolls of solar cells forming a continuous process," he says.

"That would make production a lot cheaper, faster and cleaner. The reduction in weight would also reduce transport, labour and supporting materials."

The lightweight nature of the new generation of solar panels would also mean they could be used in more flexible applications: on façades and windows of buildings, and in hilly areas.

"The world is a very beautiful place and I want to help to preserve that," says Lam, who also majored in Chemistry and minored in Ecology and Conservation Biology.

"I feel that this research topic is a really good fit that combines both my passions and my background knowledge. I am super excited to continue on."

RIGHT: Phil Woodford, CNF & Associates.

LEADING THE WAY IN HYDROGEN

Phil Woodford

Technical Lead, CNF & Associates

NUMEROUS WORLD firsts were achieved during the construction of the Hydrogen Energy Supply Chain (HESC) Project.

First was the fact that Australia's hydrogen industry was finally exporting liquid hydrogen.

Then there were the facilities at the Port of Hastings, designed and developed to enable the liquefaction of hydrogen gas and its transport to a ship for export.

Finally, there was the ship on which it was exported, the *Suiso Frontier*, which was built from scratch as the world's first hydrogen carrier.

In its commercial phase, HESC is projected to reduce annual global CO₂ emissions by 1.8 million tonnes – the equivalent of removing 350,000 cars from the road.

Australian engineers will need to contribute a lot of expertise if the nation is to achieve its goal

"But we've known how to handle liquid hydrogen commercially for decades, and gaseous hydrogen for over 100 years. Putting that knowledge and experience together, then convincing the broader community that it's safe and reliable and of no risk to them, that's the challenge."

Hydrogen is simply another industrial gas, Woodford says. It has certain characteristics, but



"IT REQUIRES ENGINEERS WHO HAVE AN APPETITE FOR RISK, WHO UNDERSTAND THE RISK AND WHO HAVE THE CONFIDENCE TO ADDRESS THAT RISK."

of becoming a global leader in hydrogen production and export, but much of this knowledge Australia's engineers actually have already.

"One of the big challenges in any project is bringing along the community with you, whether it's the engineering community, the general community or the industrial community," says Phil Woodford CPEng who, as Technical Adviser for Kawasaki Heavy Industries' hydrogen terminal at the Port of Hastings, helped build the world's first liquefied hydrogen export terminal.

if we approach its production and transport the same way we would any other industrial gas – methodically addressing and mitigating each risk – then Australian engineers and all stakeholders, including local communities, will develop confidence around using hydrogen to store energy.

"We also need to offer electives relevant to industrial gases, relevant to hydrogen and relevant to cryogenics at university," he says. ▶



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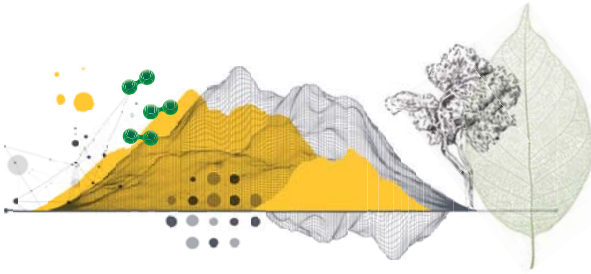
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“If we’re serious about global warming, and if we’re serious about not burning fossil fuels, we can only use renewable energy – wind or solar – to power electrolyzers [which use electricity to split water into hydrogen and oxygen]. We have to produce hydrogen that way.”

Electrolyzers are beginning to ramp up in size, Woodford says.

But “farms of electrolyzers” will be needed before it will be possible to produce hydrogen on the scale required to establish a globally recognised hydrogen export industry.

Australia will also need consistency of messaging from government around energy policy and export vision, and greater technological self-confidence from Australian engineers.

“That also means Australian superannuation funds and companies investing in sunrise industries that are going to grow,” Woodford says.

“For that, we need engineers leading the decision-making process. It requires engineers who have an appetite for risk, who understand the risk and who have the confidence to address that risk.”

MULTI-DISCIPLINARY, COLLABORATIVE SOLUTIONS

Nerida Horner

Group Leader Landscapes and Ecology, Northern Australia Science Consultant, CSIRO

Nerida Horner is a multi-disciplinarian with a passion for narrowing the gap between academic research and real-world implementation, particularly when it comes to sustainability challenges.

“Very early on I could see there were few environmental problems

Territory, Western Australia and Queensland.

Horner’s most recent expression of this lay in fostering, creating and leading the inception of the Darwin Living Lab (DLL), a 10-year collaboration between the CSIRO, the federal and territory governments, and the City of Darwin.

The virtual innovation lab applies research with experimentation on the ground in Darwin, seeking to prepare the city for a more liveable, sustainable



RIGHT: Nerida Horner, CSIRO.

“VERY EARLY ON I COULD SEE THERE WERE FEW ENVIRONMENTAL PROBLEMS THAT EXISTED IN A VACUUM. MOST WERE ALSO SOCIETAL PROBLEMS.”

that existed in a vacuum,” she says. “Most were also societal problems.”

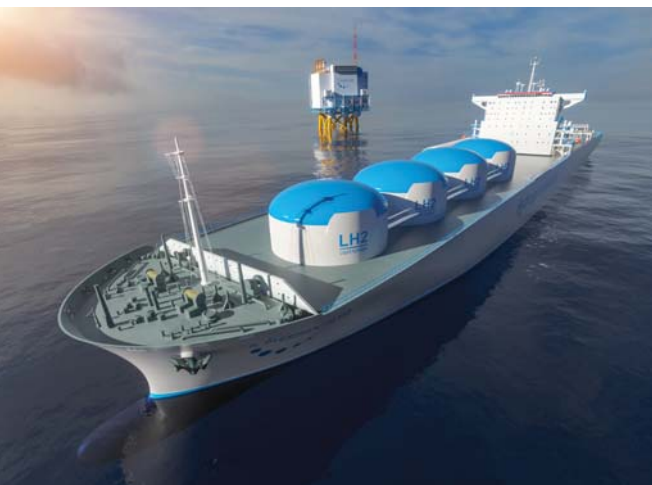
This knowledge was confirmed during a period of more than a decade during which she worked in water demand management with remote Indigenous communities.

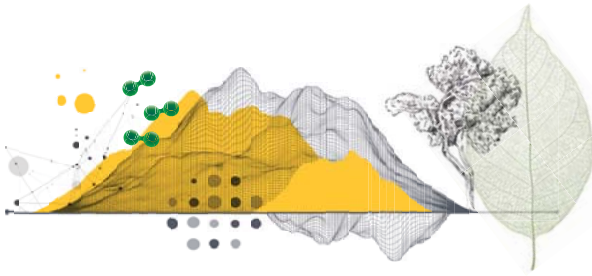
Her achievements include numerous environmental challenges she helped solve in operational and leadership roles in utility, non-governmental organisations, research and government across the Northern

and resilient future in the face of a changing climate.

Her role in the DLL involved bringing together experts from government, academia, industry and community to co-create powerful solutions around resource efficiency and urban design, and to respect Indigenous knowledge in mitigation of the effects of a warming climate.

In this role, Horner’s knowledge and experience in environmental engineering, utilities, water and ▶





waste management, sanitation and Indigenous engagement have very much been used.

“When greening a city to make it more climate-change resilient and more liveable, we must consider its context, the climate 20 years from now, availability of water and energy, and more,” she says.

“Achieving sustainability and resilience will rely on sound engineering principles with relevance to the human and environmental context.”

RIGHT: Horner led the creation of the Darwin Living Lab.



“ACHIEVING SUSTAINABILITY AND RESILIENCE WILL RELY ON SOUND ENGINEERING PRINCIPLES WITH RELEVANCE TO THE HUMAN AND ENVIRONMENTAL CONTEXT.”

Horner has been managing such conversations on behalf of the CSIRO in Darwin for more than seven years and, recently, in her move to North Queensland 18 months ago.

“My role in northern Australia is an outreach and brokering role, listening to organisations to identify their challenges and to see how the CSIRO and our collaborators can help them solve those challenges,” Horner says. “We can then develop collaborative approaches more impactful than the sum of their parts.”

Major innovations have included influencing new building design

and informing strategies for heat mitigation, climate change and waste management.

“We have developed an app to better manage heat stress for outdoor workers,” she says. “We’re quantifying progress on greening initiatives with satellite methods and are bringing local Larrakia knowledge to the table.”

In Horner’s opinion, the most impactful innovation has been the establishment of a “motivated innovation community”, backed by three levels of government, deep community support and the CSIRO.

“Practitioners, policymakers in government, scientists and engineers have previously made decisions individually and from within their own organisations,”

she says. “The DLL supports them with ready access to a local network of experts, interested community and a direct link to the CSIRO and our national [research and development] capability.”

“Engineers have a really good appreciation of what we must draw from to solve problems right now. We’re often responsible for implementing technical solutions in a real-world scenario. But no matter who is involved, the sharing of information and the social mandate for change are the essential ingredients for success.” ▶

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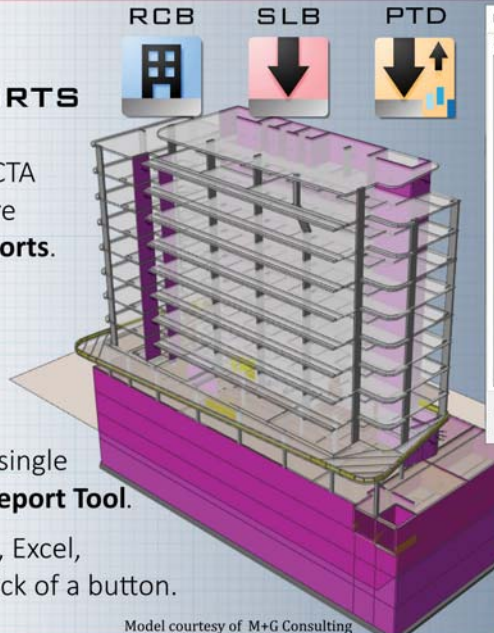


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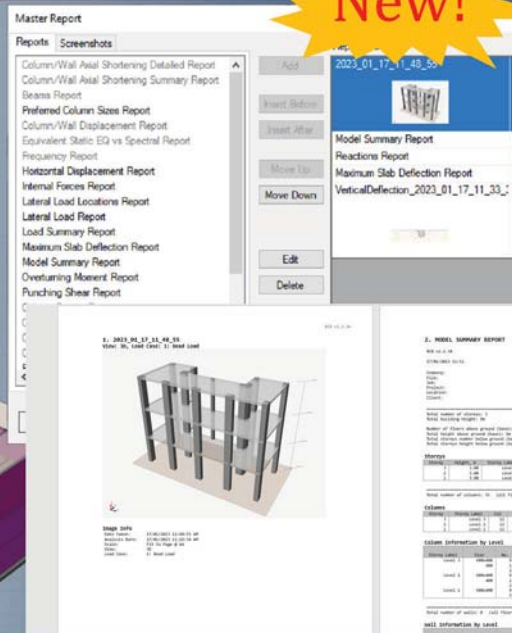
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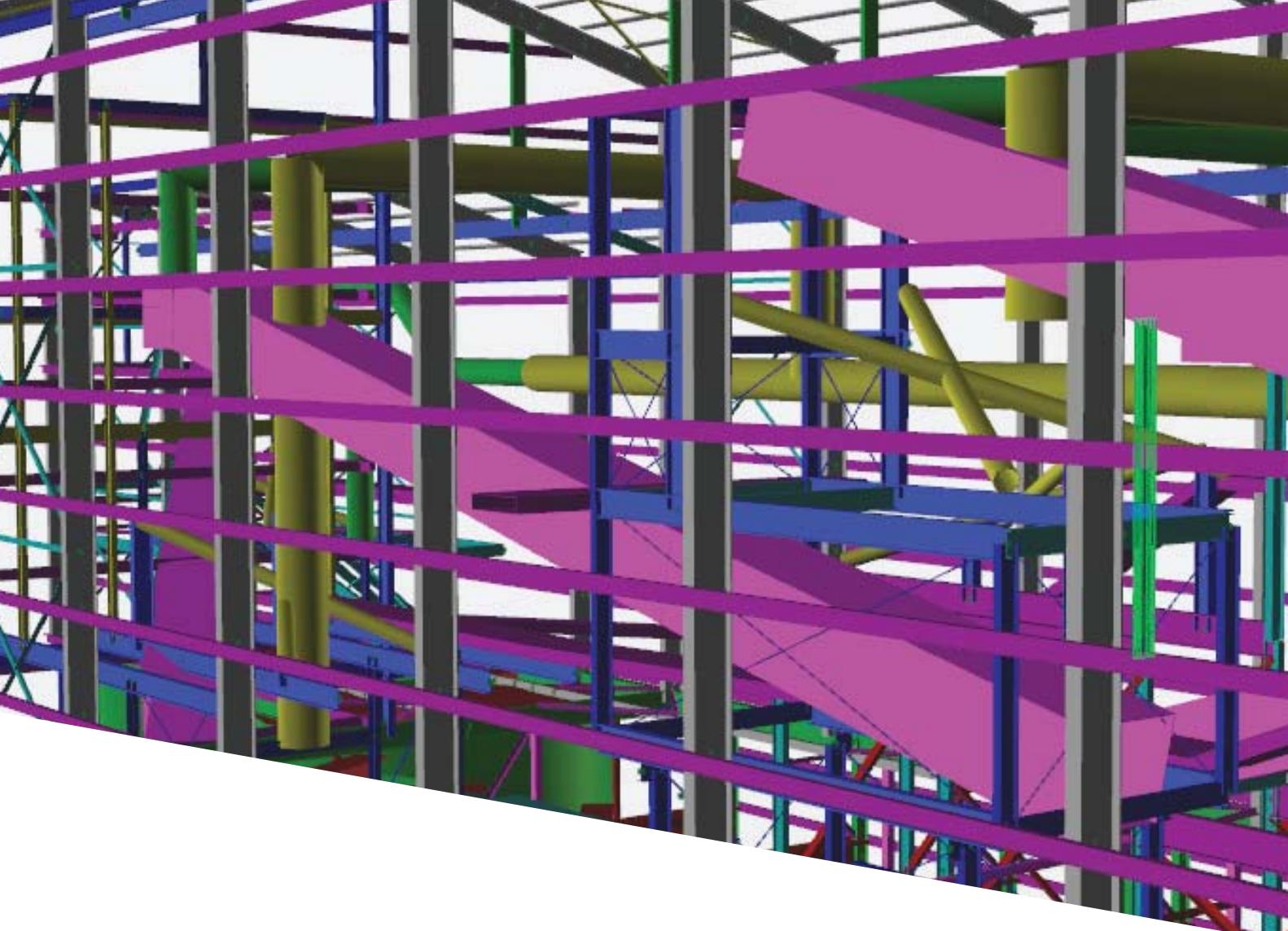
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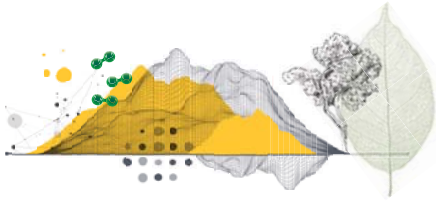
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SIMPLIFYING AND SHARING

ALAN NOBLE

Founder and CEO AusOcean

How does an electrical and electronics engineer who spent more than a decade with Google use his knowledge and experience to launch a business that solves ocean science challenges?

"I'm glad you asked," says Alan Noble FIEAust. "To answer, I have to go back in time.

"My career started out in the semiconductor industry in computer-aided engineering in



those devices accessible to all scientists.

In 2017 he took long-service leave to do just that. AusOcean was born.

Using low-cost technology, such as Raspberry Pi computers, he married his belief that technology could be a real differentiator with his long-term love of oceans.

"An early project was one in South Australia: an oyster reef restoration project," Noble says.

"They were desperate to put in place monitoring technology but were struggling with how to do it. We developed low-cost underwater cameras, hydrophones and speakers for them. It was a technology and engineering problem, albeit with a conservation and restoration objective."

AusOcean now operates in the non-profit space, looking at problems technology can help solve. Good engineering has played a leading role in the organisation's success.

"We spend a lot of time ruggedising low-cost electronics so it can live underwater," he says. "We're very fond of PVC.

"Early on, we also moved away from air-filled housings to oil-filled housings, because air-filled is only fine until you spring a leak. Then, it's very unforgiving. But oil-filled can be designed to be pressure compensating, so even with some water ingress, you can avoid a catastrophic failure."

Noble encourages every engineer in every field to consider the impact they're able to have on sustainability.

"I would encourage engineers, especially young engineers, to be thinking about impact," he says.

"Ask the question, 'If I make this design choice, it will have a product impact but could it have a broader impact? What impact is it having on the environment? Could it affect sustainability?'

"I would like to see more engineers, when they tackle problems, thinking about impact." ●

"I WOULD ENCOURAGE ENGINEERS, ESPECIALLY YOUNG ENGINEERS, TO BE THINKING ABOUT IMPACT. WHAT IMPACT IS IT HAVING ON THE ENVIRONMENT? COULD IT AFFECT SUSTAINABILITY?"

Silicon Valley. I ended up working for a couple of tech start-ups and eventually came back to Australia, with a few more tech start-ups. Then I worked for Google.

"The theme for all of those years was technology in its various forms."

Technology, he came to realise, was of value because it enabled businesses to do more with less and to scale more quickly.

When Noble began having conversations with people in marine biology, he realised they were not using technology as well as they might.

That wasn't necessarily their fault; they had the desire, if not the knowledge. But the only

technology available to them was extremely expensive.

"That tech was over-engineered for extreme depths and extreme pressures," he says. "Even a simple sensor, like a salinity sensor - that I could design and build for a couple of hundred dollars - ended up costing thousands."

Noble realised he could make these devices far more affordably. More importantly, he could also design an open-source system that made the data from, and design of,



ABOVE:
Alan Noble,
AusOcean.

WORDS BY CHRIS SHEEDY

SMART

GOOD ENGINEERING REQUIRES A CLEAR FOCUS ON THE END USER. FEW ENGINEERS UNDERSTAND THIS BETTER THAN LIAM HIGHMORE, WHOSE COMPANY HOMEABLE DESIGNS SOLUTIONS FOR PEOPLE WITH UNIQUE REQUIREMENTS.

THE IDEA of a smart home has attracted – and often eluded – countless homeowners.

Whether for simplicity, security, efficiency or just out of curiosity, many of us have added smart lighting, video doorbells, power plugs, digital deadbolts and more.

Then, when these devices mysteriously stop doing what they are supposed to do, we wonder why we didn't just stick with the tried and tested.

Liam Highmore, co-founder and CEO of Homeable, launched his business around the idea of creating smart

SOLUTIONS

homes that live up to the “smart” in their name. But he quickly recognised a specific market that needed these services much more than most.

“The business was born out of a design-a-thon that was run by an organisation called Remarkable,” says Highmore. “They were exploring ways to make smart home technology more accessible.

“From our point of view, we were determined to level

the playing field by enabling everyone to create the smart home of their dreams.

“But the more we spoke to people and the more we explored this issue, the more we realised that no one was doing this specifically for the disabled community.”

There is a large proportion of people living with a disability who could benefit from smart home technology, Highmore says.

His co-founder Luke Ray has a brother who is quadriplegic and inspired a lot of the team's early work.

“It’s crazy how much of our technology and devices aren’t designed with disability in mind,” Highmore says.

NOT-SO-SMART HOMES

The first challenge in working with smart homes, Highmore says, comes from the fact that most homes simply aren’t smart.

“There is so much technology out there – a ridiculous amount,” he says. “But often, this technology isn’t suited for or appropriate to the individual.

“The concept of a smart home has promised a lot of things in the last decade. However, most of those promises haven’t materialised. It’s important to recognise the fact that smart homes today are typically connected but not smart.”

This lack of delivery comes from the fragmented technologies that have led to a lack of standardisation. It also comes from security and privacy concerns.

“At the end of the day, that often leads to poor customer experiences,” Highmore says.

“That’s why we chose not to just focus on the technology, but also the process that people go through in creating a smart home. We want to provide value to our community, not just put technology in homes for the sake of it.”

Not everyone is a tech expert. But the promise of this particular technology, he says, is that you don’t need to be an expert to enjoy all it has to offer.

THE RIGHT TOUCH

In designing smart home solutions for people living with a disability, Highmore and his colleagues start with the manufacturers, ensuring every product is accessible, easy to use, and works harmoniously with the company’s app.

Next, they find the right installers, which, in such a

competitive talent environment, is easier said than done.

“That’s one of our biggest challenges,” he says. “We’re not just looking for an electrician or an occupational therapist.

“We’re looking for someone who has the ability to empathise, who has an understanding of the challenges of living with a disability. A unique cocktail of skills is required to be in this business area.”

The business employs various systems-engineering design principles to design and install a solution for someone with a disability.

Site visits require a degree of safety awareness as well as

empathy and awareness that’s required.

“For example, often you’re not just installing a security camera,” Highmore says.

“You’ve got to consider that loud noises or flashing lights could have negative effects on the client; they could induce seizures in certain individuals. So there are a lot of things we need to consider before just hammering something into a wall.”

Before Homeable begins designing a solution, the client – or somebody in the client’s network – completes a questionnaire outlining their independence goals. ➤

BELOW: Liam Highmore and the Homeable team design bespoke automation solutions for their clients’ needs.



knowledge of networking and radio frequency protocols.

“The design process we employ is very similar to that of a traditional engineering design, aligning our products and solutions to the needs and goals of the individual,” Highmore says.

“But the installation is the one area where we differ from many traditional engineering firms. There is an added degree of

“THE MORE WE SPOKE TO PEOPLE AND THE MORE WE EXPLORED THIS ISSUE, THE MORE WE REALISED THAT NO ONE WAS DOING THIS SPECIFICALLY FOR THE DISABLED COMMUNITY.”

Based on those preferences and requirements, a bespoke home automation solution is designed.

A site visit follows, including a full assessment of the network. This involves signal strength testing in every room.

“We’re still working out the best ways to approach that, because no two houses are the same,” Highmore says.

“One of the common reasons for things not working as well as they should is the stability of the network in each house.”

The relationship with the client doesn’t end there. Homeable continues to educate and support them so they can get the most out of the technology.

FUTURE STANDARD

The technology companies in the smart home field are acutely aware of the issues caused by the fact that their various offerings do not play nicely together.

That’s why, Highmore says, a new smart home and Internet of Things standard called Matter was launched in late 2022.

It is backed by Apple, Google and Amazon, three of the biggest players in the smart home game.

Matter has been developed to ensure users no longer have to read the fine print to discover whether a specific device from a particular brand will do what it is designed to do within their home’s

ABOVE: Finding the right installers is an important part of Homeable’s approach.

system. In theory, everything will just work.

“The industry previously made things very difficult to navigate,” Highmore says.

“It has been hard for consumers to find the right technology that works with what they have.

“This standard seeks to unify all the connected devices. I think this is going to drive the transition from connected home to smart home.”

Advancements in artificial intelligence will allow homes to begin to predict and modify their own environment according to the habits of the people who live there, Highmore says.

“We’ve started to see it already, but I think we’ll begin to see an influx of health sensors that help keep tabs on wellbeing,” he says.

“I think that will go a long way in assisting the elderly to stay at home for longer, and inevitably reduce a long-term toll on the health system.” ●

“THIS STANDARD SEEKS TO UNIFY ALL THE CONNECTED DEVICES. I THINK THIS IS GOING TO DRIVE THE TRANSITION FROM CONNECTED HOME TO SMART HOME.”



ACCESS GRANTED

For Homeable CEO Liam Highmore, the future of home automation is all about accessibility.

“It has to be inclusive, because you’re not just designing for one person,” he says. “You’re often designing for family, carers and friends who come over.

“Many engineers, particularly those working in the public space, often don’t have a lot of interaction with the intended user of the building or the piece of infrastructure they’re designing or constructing.

“But doing this work in a residential environment has reminded me of the importance of putting the user at the heart of everything we do as engineers. If what we do fits the needs and goals of the end user, it’s a win.”

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WORDS BY MICHELLE WHEELER

OPENING DOORS

AMID AUSTRALIA'S WORST EVER SKILLS SHORTAGE, MIGRANT ENGINEERS STILL FACE SIGNIFICANT BARRIERS TO EMPLOYMENT.

WHEN STRUCTURAL engineer Alyaa Ahmed arrived in Australia four years ago, she had a decade of experience designing apartment buildings in Egypt and Kuwait.

Her partner - an electrical engineer - was able to get work. After all, electricity is the same the world over.

But Ahmed found it very difficult.

"In the Middle East, the majority of the structural engineers are using concrete in the buildings," she says.

“But here, most of it is steel. So I couldn’t find any jobs [with] my experience.”

Ahmed felt like she was forced to start her career again as a fresh graduate.

“That was challenging to cancel all my 10 years’ experience and start from scratch again,” she says.

It took her two years to find work, eventually landing a role as a steel detailer at Strangio Structural Steel. While still not using her engineering degree, she’s grateful to be in an Australian workplace.

“They ask us for local experience, and we don’t have the option to [do] even unpaid training,” Ahmed says.

“If you are lucky, you will have a local company or a good project manager that gives you this opportunity to prove yourself. But this first step is very hard.”

More than half – 58 per cent – of Australia’s engineering workforce was born overseas, and the community benefits heavily from their collective expertise and contributions.

Migrants typically account for two-thirds of the growth in the engineering workforce each year, with the remainder university graduates.

Engineers Australia research as shown migrant engineers play an important part in strengthening Australia’ engineering workforce.

But despite Australia experiencing its worst-ever skills shortage, Ahmed is not alone. It takes overseas-born engineers longer to find employment in engineering.

They have a higher rate of unemployment and are more likely to be underemployed than Australian-born engineers.

Worst affected are overseas-born female engineers,



ABOVE RIGHT:
Ian Mulekyo.



Sydney to study a master’s in water engineering.

Mulekyo finally graduated – and then COVID-19 hit.

His skilled migration visa also proved problematic, with most companies only wanting to hire permanent residents or citizens.

Even though Mulekyo was allowed to work for 18 months, employers either didn’t understand the visa or didn’t want to take the risk.

While finishing his master’s, Mulekyo found support through Host International.

“They kept on sending us emails of potential employers,” he says.

“IF YOU ARE LUCKY, YOU WILL HAVE A LOCAL COMPANY OR A GOOD PROJECT MANAGER THAT GIVES YOU THIS OPPORTUNITY TO PROVE YOURSELF. BUT THIS FIRST STEP IS VERY HARD.”

who have almost three times the unemployment rate of Australian-born female engineers.

HURDLES AND DELAYS

Civil engineer Ian Mulekyo arrived in Melbourne on a 476 skilled migration visa with an engineering degree from the international campus of an Australian university.

He spent six months searching for a job without success, before moving to

“That’s when I started learning about the hidden job market.

“I slowly stopped looking for the big companies and started looking for companies that were growing.”

Mulekyo ultimately moved to the Sunshine Coast to take a role with Colliers Engineering and Design.

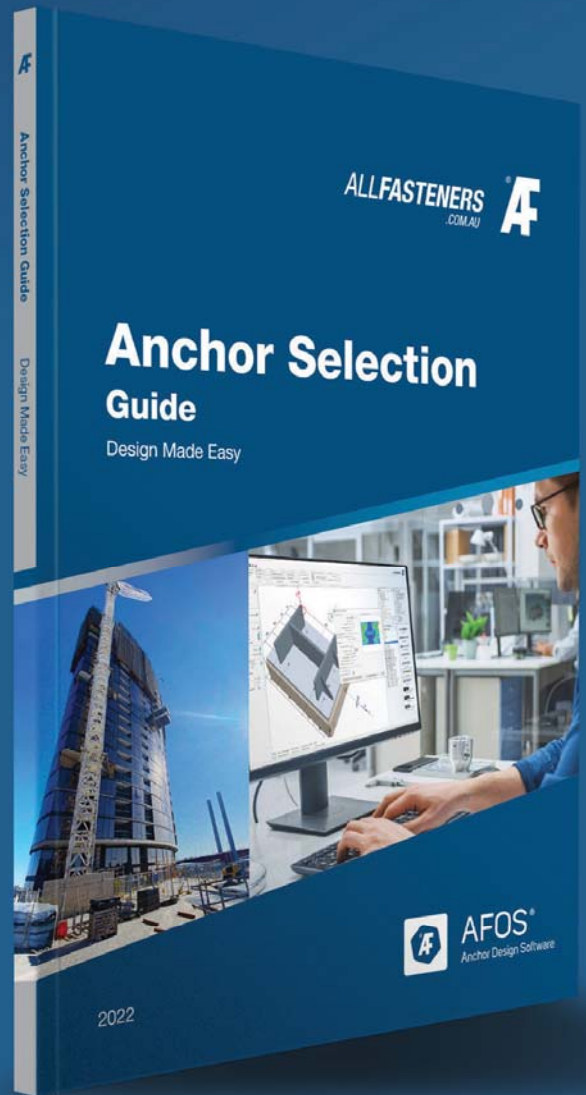
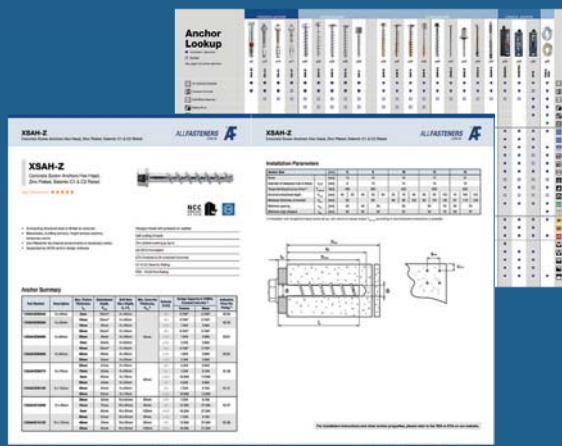
Mulekyo, who grew up in Kenya and studied in Malaysia, also took time to understand ▶



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communication differences in Australian workplaces.

“Writing an email ... where I come from it’s, ‘Dear sir, madam,’” he says. “When you come to Australia, you first start with ‘hi’. You come to realise that even ‘hi’ is just as respectful. It shows that ... someone can have a chat with you. That’s one of the key things that I came to learn later on.”

GIVING BACK

Civil engineer Tomaz Jimenez worked in construction in Brazil for nearly a decade before migrating to Australia, where he now works as a senior development associate with CIMIC Group’s Pacific Partnerships.

When he arrived in 2018, Jimenez noticed cultural differences in the way Australians manage infrastructure projects.

“They use more engineers but fewer technicians and ‘tradies’ than in Brazil, for example,” he says. “I had the support of a mentor to understand the dynamics of Australian workplaces.”

Jimenez decided to give back by becoming a mentor himself.

He started with an engineer from South Africa in 2019, and since joining Host International has mentored three other migrant engineers.

To his mentees, Jimenez highlights the importance of networking, providing more direct feedback, and seeking constructive feedback from their leaders at work.

He also finds Engineers Australia’s *Construction Engineer Learning and Development Guide* very useful for recent migrants to navigate the different roles on Australian construction projects.

For Jimenez, there have been benefits as a mentor too. He is currently working with an Afghan civil engineer who moved to Australia on a humanitarian visa.

“It’s very rewarding,” Jimenez says. “It’s such a pleasant way of spending [an hour a week or fortnight]: getting to know someone, understanding their challenges and strengths.” ●

BELOW:
Tomaz Jimenez.
RIGHT:
Jimenez with a
CIMIC colleague.



“I HAD THE SUPPORT OF A MENTOR TO UNDERSTAND THE DYNAMICS OF AUSTRALIAN WORKPLACES.”

Mentoring matters

Ginna Alvarez is hoping to capitalise on the experience of someone like civil engineer Tomaz Jimenez.

The environmental engineer arrived in Australia from Colombia two and a half years ago and is currently studying a master’s in environmental management in South Australia.

But Alvarez has struggled to find an entry-level role or part-time work in engineering while studying.

“I don’t want to keep trying and failing,” she says.

Alvarez is planning to do an unpaid internship and was recently matched to an Australian mentor

through a partnership between Host International and Engineers Australia.

She wants to draw on her mentor’s experience to understand where she should start in the search for an engineering role.

Alvarez also hopes the mentor will help get her involved in the industry and improve her networking skills.

“I really will appreciate to learn from her how to start with a LinkedIn profile, how to navigate that to make new contacts,” she says.

“I really want to know how all the companies work. I want to learn tips of how to get a job, like [in] interviews.”



WORDS BY MICHELLE WHEELER

ROLE MODEL

THE DESIGN OF A COMPLEX BRIDGE IN MELBOURNE'S SOUTH-EAST IS LEADING THE WAY IN THE TRANSITION FROM 2D TO 3D DELIVERY.

IT'S AN infrastructure designer's nightmare. Midway through the delivery of a complex bridge design, the engineering team on Melbourne's Lathams Road project realised the data they were working with was wrong.

The as-built position of an existing structure was out, both vertically and horizontally. It meant the entire new bridge they were designing had to be moved.

"The existing abutment was 300 mm off," says Hatch Senior Bridge Engineer Tanmay Vegad. "When we had the new structure on, all our abutments and piers had to be aligned, so that the actual envelope [was] consistent across the two structures."

Usually, realigning a whole bridge late in the game would take a month. But the team was using a new 3D approach.

"Using the 3D modelling ... the entire structural model is linked to a civil alignment," Vegad says.

"We just had to update the location and it automatically makes those changes across all the sheets. So that was a week's worth of work versus four to five weeks' worth of work if it was any other way."

CHALLENGING DESIGN

The survey data was one of many challenges on the project, a two-span continuous bridge in Melbourne's south-east.

The scope of work strengthened and duplicated an existing bridge over the Mornington Peninsula Freeway, adding a new lane in each direction.

It had to be built without shutting the freeway – a major arterial road – at any point during construction.

"All our designs of the bridge itself were meant to follow a specific construction sequence and detailing such that there were no disruptions to the freeway itself," Vegad says.

"Most importantly, of course, is that the bridge [could] be constructed safely, without any risk to the road users or to any maintenance work, construction work ... especially around constructing the embankments."

With substantial earthworks required, Vegad says the team thought carefully about the materials used and worked with internal and external specialists to lessen the project's impact on the environment.

"One of the things that we've adopted in the design as well is to recommend a lot of sustainable



ABOVE: Hatch's Tanmay Vegad (top) and Ondrej Krivka. **RIGHT:** A 3D model of the Lathams Road bridge.



materials," Vegad says. "Recycled crushed concrete, recycled plastic, reclaimed asphalt and the like."

The project would go on to be awarded the 2021 Hatch Global Award for Sustainability, and was a finalist in the 2021 Going Digital Awards in the Infrastructure – Bridges category.

AUSTRALIAN FIRST

The Lathams Road bridge designers were the first in Australia to use a new 3D



“THE ENTIRE STRUCTURAL MODEL IS LINKED TO A CIVIL ALIGNMENT. WE JUST HAD TO UPDATE THE LOCATION AND IT AUTOMATICALLY MAKES THOSE CHANGES ACROSS ALL THE SHEETS.”

modelling product called OpenBridge. Hatch senior structural designer Ondrej Krivka, the lead designer on the project, says it was a big challenge moving from 2D to 3D digital delivery.

Krivka says the Bentley software had to be adapted for Australian standards, such as different abutments and precast barriers.

“It’s always a learning curve when you have a new software

and [are] using it on the project at the same time,” he says.

But there were several advantages. The team used a program called LumenRT, a real-time visualisation software that allows engineers to present their design on site.

“They can use a mobile phone [or] special glasses where they just can look around and see the actual model sitting there already,” Krivka says. “It gives you a bit of ▶

perspective of how it will look. It's also good for the client to see it."

Vegad says the team also used 3D modelling to assess the collision barriers on the existing bridge and bring them in line with current standards.

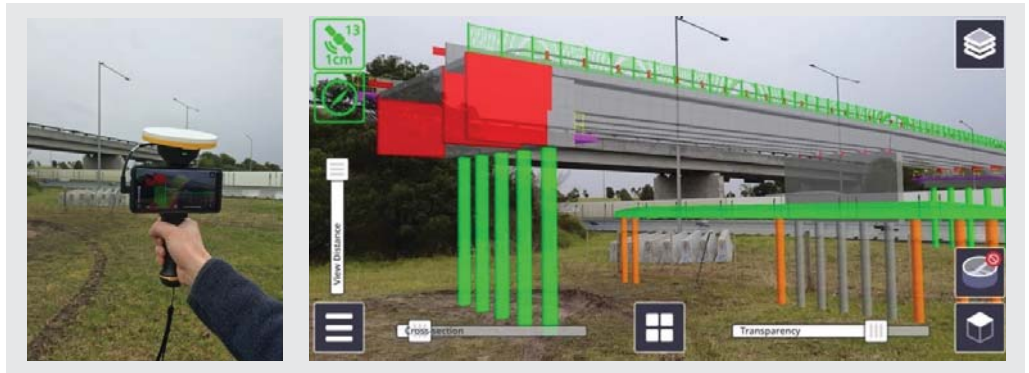
"To rip all [the collision barriers] out and do a new construction would be extremely expensive, extremely disruptive and also not sustainable at all," he says.

Instead, the team did a full assessment of the existing structure and designed a new steel railing that made use of existing connections.

"We could work out the amount of steel used and work out the most efficient way to replace it with [the] minimum steel we could use," Vegad says.

FUTURE DESIGN

Dave Body, Senior Industry Strategy Manager for Civil Infrastructure at Bentley, sees a transformational change taking place from traditional 2D delivery of plans to 3D digital delivery.



"THEY'VE GOT TO LEARN HOW TO MODEL IN THIS 3D ENVIRONMENT. IT'S A MORE ACCURATE, MORE DETAILED OBJECT MODEL THAT THEY PREVIOUSLY HADN'T BEEN DOING."

"There's a lot more expectation on the designer because they've still got to deliver on this 2D stuff," he says.

"But they've also got to deliver on this new 3D digital delivery. And they've got to learn ... how to model in this 3D environment. It's a more accurate, more detailed object model that they previously hadn't been doing."

Body says digital data is also becoming central to delivery. He says the biggest thing in the near future is extended metadata, or attributed data.

"For example, [Transport for New South Wales], they're now requesting anywhere up to 65 bits of extra attributed data that needs to be associated with each and every object or component on a bridge," he says.

Body thinks the transition will impact the market heavily over the next five years or so. He says this digital data can include unique asset classification or location codes.

"Somewhere along the workflow ... this information needs to be attributed to that object," he says. "It needs to be created or configured, it needs ▶

ABOVE: Real-time visualisation of the project.
BELOW: Dave Body, Bentley.



A stitch in time

To construct a bridge above a live freeway, the engineers designed two spans that could be lifted into place without closing the road below.

The spans were then stitched together with post-tensioned stress rods above a single support in the middle of the bridge.

"That makes it a very efficient structure," says Hatch Senior Bridge Engineer Tanmay Vegad.

"Also it's a lot safer for construction, because you have less formwork, you have less materials, because these girders are all precast."

Vegad says one of the big advantages of making this stitch was that, once done, the bridge acted as a continuous stretch across the freeway.

"Apart from placing in the span itself, most of the actual construction works have been from on [or around] the structure," he says.



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“THEY’RE NOW REQUESTING ANYWHERE UP TO 65 BITS OF EXTRA ATTRIBUTED DATA THAT NEEDS TO BE ASSOCIATED WITH EACH AND EVERY OBJECT OR COMPONENT ON A BRIDGE.”

to be managed and maintained, basically within the BIM model. And then it needs to be delivered.”

PROJECT DELIVERY

The Lathams Road bridge design was ultimately delivered four weeks ahead of schedule, Vegad says.

Hatch Design Coordinator Joseph Armstrong credits the success of the bridge to having all of the main design software based on a single product,

alongside file management in ProjectWise.

“It’s pretty flawless,” he says.

“There were no extractions or conversions ... so it worked really smoothly.”

Armstrong prefers this approach over mixing file types like DWG and DGN.

“That’s when the deliverables start to fall apart,” he says.



ABOVE (from top): Constructing the bridge; **Joseph Armstrong, Hatch.**

“It takes too much time to actually try and [connect] these three software together.”

For Vegad, the complexities of the project are what made it exciting.

“The whole purpose of this project was so that communities that live at that location would have a much-improved road system,” he says.

“The construction sequences that were required in order to not disrupt it, especially all the sustainability initiatives that were adopted ... made it worthwhile.

“And also, the complexities of working around an existing structure and working with a lot of stakeholders, disciplines, utilities and interesting challenges.” ●

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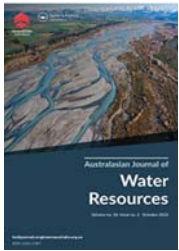
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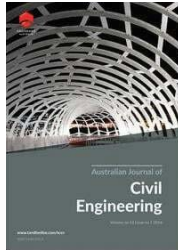
HIGHLIGHTS FROM AUSTRALIA'S MOST UP-TO-DATE ENGINEERING RESEARCH



CONCRETE IN THE CITY

Journal: *Australasian Journal of Water Resources*
Author: K. Harriden

Despite the hydrological imperative and engineering capacity for change, concrete storm water infrastructure remains obdurate in the urban waterscape. This obduracy manifests both as an unwillingness to remove existing infrastructure and the continuing construction of new infrastructure in locations previously free of these systems. This paper identifies four critical socio-political values underlying the obduracy of concrete storm water infrastructure and the resultant urban stream syndrome.



PERTINENCE OF ALTERNATIVE FINE AGGREGATES FOR CONCRETE AND MORTAR: A BRIEF REVIEW ON RIVER SAND SUBSTITUTIONS

Journal: *Australian Journal of Civil Engineering*
Authors: B. Arulmoly & C. Konthesingha

Construction industries around the world are facing many difficulties in obtaining good-quality fine aggregates for concrete and mortar due to a shortage of river sand, a problem that led the researchers to find possible alternatives. This paper considers the merits and demerits of substitutions, availability of standards, and previous studies on the effects of replacing river sand.



SUPER-CONDUCTING AND NON-SUPER-CONDUCTING FAULT CURRENT LIMITERS: THE DEVELOPMENTAL JOURNEY AND UPCOMING PROSPECTS

Journal: *Australian Journal of Electrical and Electronics Engineering*
Author: A. K. Singh, N. Singh & A. N. Singh

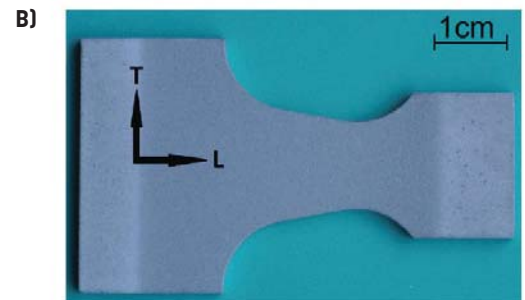
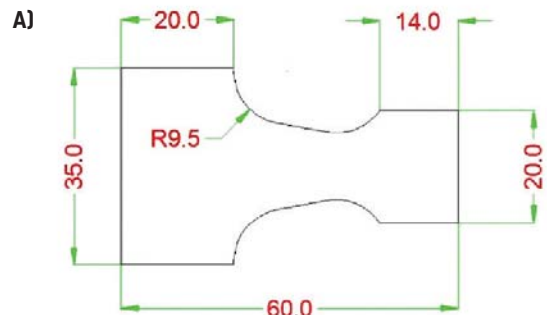
The continuous addition of non-linear loads to the existing power system brings a heavy in-rush of fault current, leading to transient instability in the system. To protect the system and its precious elements, fault current limiters (FCLs) are installed. This article elaborates on the current challenges of FCLs, future perspectives and their market potential.



A review on characteristics of cold-sprayed coatings

Journal: *Australian Journal of Mechanical Engineering*
Authors: A. Srikanth & V. Bolleddu

This paper explores characteristics of cold-sprayed coatings. In addition, the performance of cold spray-coated specimens in the view of microstructure, mechanical and corrosion studies is reviewed. The research examines the presence of defects in the cold-sprayed coatings and critically analyses the impact of these defects on the performance of coatings in numerous situations. It then identifies methods to improve the performance of cold-sprayed coatings and confers the importance of process parameters, particle size, melting point and hardness.



RIGHT: Test specimen suggested by ASTM-B593, which has a uniform stress distribution under bending: (a) detail design of the specimen (all dimensions are in mm); (b) view of a prepared specimen presented (Ghelichi et al. 2012).





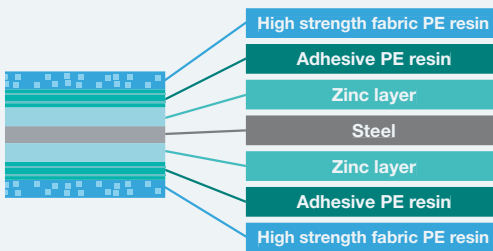
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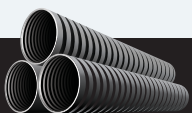


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<p>27-01 FEB-MAR 2023 AUSTRALIAN INTERNATIONAL AEROSPACE CONGRESS (AIAC20)</p>	<p>Location: in-person Melbourne and Avalon Website: aiac.com.au Landing back in Melbourne this February, three unmissable days of professional development and networking will explore leading technologies and research for the future of civilian and defence aerospace. This congress is held in conjunction with the Australian International Airshow and Aerospace and Defence Exposition at Avalon.</p>
<p>03 MAY 2023 AUSTRALIAN CONSTRUCTION ACHIEVEMENT AWARD (ACAA)</p>	<p>Location: in-person Melbourne Website: acaa.net.au The Australian Construction Achievement Award, presented by the Australian Constructors Association and Engineers Australia, brings together the best construction projects, delivered by the nation's very best construction companies. Now in its 26th year, the ACAA black-tie dinner will be hosted in conjunction with the Future Construction Summit 2023. Register now</p>
<p>19-21 JUN 2023 CONFERENCE ON RAILWAY EXCELLENCE 2023 (CORE)</p>	<p>Location: in-person Melbourne Website: core2023.org The premier technical conference in Australasia's rail industry calendar is celebrating 25 years in motion. This year will highlight technological and industry developments which are increasing and enhancing the effectiveness of rail. Register now</p>
<p>15-18 AUG 2023 AUSTRALASIAN COASTS AND PORTS</p>	<p>Location: in-person Sunshine Coast Website: coastsandports2023.com.au This is the pre-eminent forum in the Australasian region for professionals to meet and discuss issues related to coasts and ports. The conference theme for 2023 is "Working together: 50 years of coasts and ports". Register now</p>
<p>29-30 NOV 2023 CLIMATE SMART ENGINEERING CONFERENCE 2023 (CSE23)</p>	<p>Location: in-person Melbourne Website: engineersaustralia.org.au/cse Now in its third iteration, CSE23 will return in-person with a full technical and plenary program. Abstract submissions are now open. Don't miss your chance to inspire the profession to be at the forefront of achieving net-zero emissions. Abstracts close 12 April 2023</p>



International Women's Day

Location: in-person Melbourne, Sydney, Perth and Brisbane
Website: eaiwd.com.au

07-09
MARCH 2023

Celebrate International Women's Day and embrace equity with Engineers Australia as we come together to foster inspiration and network with like-minded professionals at this event series. Our keynote speaker, Michelle Payne OAM, is a national icon, the first woman to win the Melbourne Cup and made "the race that stops a nation" a race that inspired one.
Register now

WORLD ENGINEERING DAY

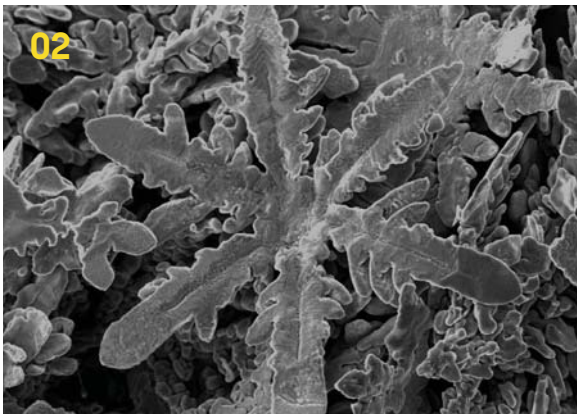
03 March 2023

Location: online webinar
Website: engineersaustralia.org.au
In celebration of World Engineering Day join Daniel Lockney, NASA Technology Transfer Program Executive, to look at NASA's technological spinoffs. Each of these innovative advancements aims to improve life on Earth and some can impact climate change.
Register now

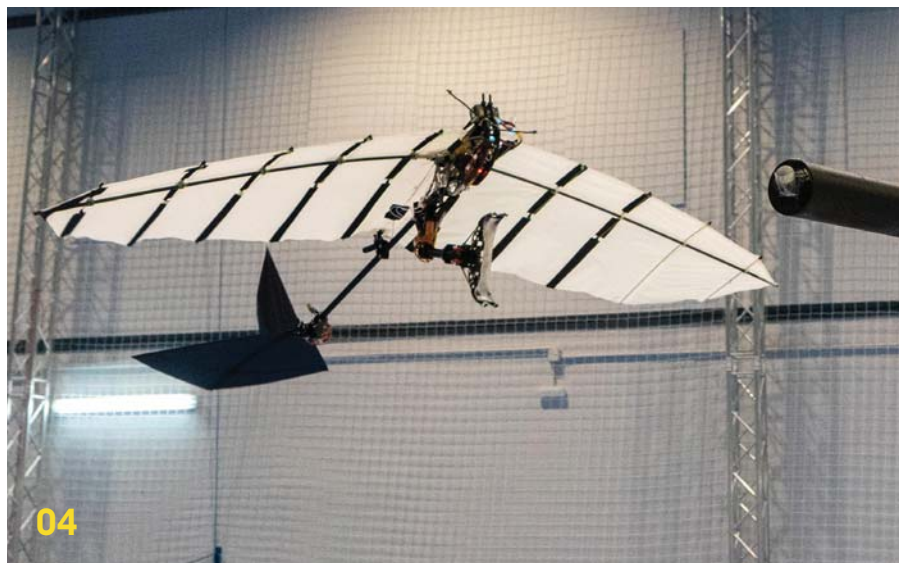
THE LATEST DEVELOPMENTS FROM AROUND THE WORLD.



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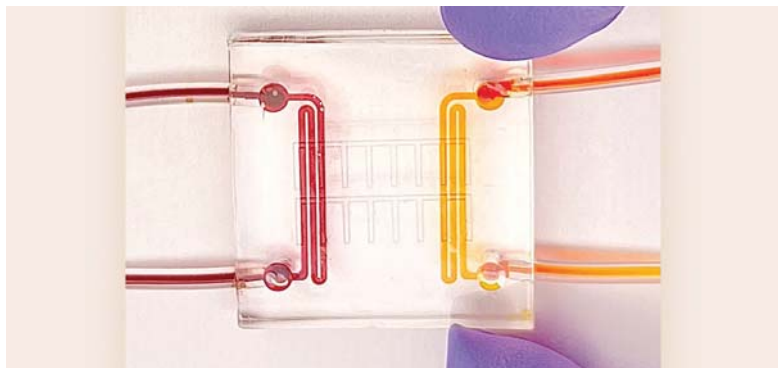


02



04

03



01 Dolphin tracker

The biologging tag is attached noninvasively behind a dolphin's blowhole.
Image: Alex Shorter/University of Michigan

Researchers at the University of Michigan have created a biologging tag that can be used to record data about dolphin activities. Like a fitness tracker for cetaceans, the wearable sensor attaches to a dolphin and collects information about the creature's energy use. "Our goal is to use tag data to estimate foraging events, how many fish were consumed during a day, and connect that to estimates of how much energy dolphins use during the movement required to catch those fish," says University of Michigan Assistant Professor of Mechanical Engineering Alex Shorter. "This is important for conservation because we can then use our approach to estimate energetic costs when these animals are disturbed." Attached with suction cups between a dolphin's blowhole and dorsal fin, the tag collects information about speed, temperature, pressure and movement, along with the sounds the animal produces and hears.



02

Zinc "snowflake"

A distinctively shaped crystal of zinc is grown inside a solute of liquid gallium.
Image: Dr Jianbo Tang

A technique developed at the University of New South Wales's School of Chemical Engineering produces a snowflake-shaped zinc crystal inside a solvent of liquid gallium. The distinctive lab-grown crystals can be synthesised in various configurations to produce semiconductors for use in electronic and computational devices, as well as contributing to the production of catalytic materials that can create hydrogen from organic fuels. By changing temperature, pressure, duration and the concentration of the gallium solute, the engineers produce a variety of zinc structures. Applying electric current to the gallium, the team overcome the surface tension that prevented the crystals from separating after they had formed. "Our method is useful for making various types of metallic crystals with selected facets," says Dr Jianbo Tang. "This enables us to control not only the shape of the crystals that are grown, but also their performance in applications such as catalysis, where different exposed crystal facets can make a significant difference."

03

Miniature "heart attack"

A small, clear chip allows researchers to mimic a heart attack in its channels.
Image: Megan Rexius-Hall

Biomedical engineers at the University of Southern California have created a chip that mimics a heart attack that could one day be used to develop new cardiac drugs. Using a micro-scale model of a heart, which replicates myocardial structure and function, the device mimics a heart attack by funneling oxygenated and non-oxygenated gases through its channels. This oxygen gradient approximates the experience of a heart attack. "Our device replicates some key features of a heart attack in a relatively simple and easy to use system," says Associate Professor Megan McCain. "This enables us to more clearly understand how the heart is changing after a heart attack. From there, we and others can develop and test drugs that will be most effective for limiting the further degradation of heart tissue that can occur after a heart attack." The device can easily be examined with a microscope, meaning researchers can observe real-time changes.

04 Bird robot

The robot's claw is designed to close quickly and firmly enough to support its weight on a perch. Image: Raphael Zufferey

A collaboration between engineers at Spain's University of Seville and Switzerland's EPFL has developed a winged robot that mimics the actions of a bird as it lands on a horizontal perch. The task requires the robot

to balance speed and force along with the timing and precision of its clawed gripping device. Tested using a 700 g ornithopter, the technology makes use of an on-board computer and navigation system and external motion-capture that helps determine the device's position. The claw absorbs the robot's momentum on impact with the perch and supports its weight by rapidly closing upon landing. "Once

an ornithopter can master landing autonomously on a tree branch, then it has the potential to carry out specific tasks, such as unobtrusively collecting biological samples or measurements from a tree," says Postdoctoral Fellow Raphael Zufferey. "Eventually, it could even land on artificial structures, which could open up further areas of application."

Adela Parnell

CPEng, Senior Planning Engineer
TasWater

WORKING FOR PUBLIC UTILITY TASWATER, ADELA PARNELL WELL UNDERSTANDS HOW IMPORTANT ENGINEERING IS TO A LOCAL COMMUNITY.

AS A SENIOR Planning Engineer at TasWater, Adela Parnell values the impact her work has on her community.

"Having clean, safe water and having our wastewater managed safely and treated to a standard that's safe for the environment it's going into – that is a baseline for having a thriving community," she tells *create*.

"Because once you've got those things sorted, you can then focus on other things within your community."

Although she trained as a civil engineer, Parnell found that her talents were well suited to the water sector.

"Because civil is so broad, in a lot of ways what I am doing at the moment is just an aspect of civil engineering," she says.

"Civil engineering is not just roads and bridges. It's your pipes, it's your water infrastructure. It's the whole gamut. A lot of invisible assets come down to civil engineering as well."

Parnell's community-minded outlook extends to the engineering profession itself. She has been Chair of Engineers Australia's Young Engineers National Committee and is today President of the Tasmanian branch of the Institute of Public Works Engineering Australasia (IPWEA).

"IPWEA is public works in general – so not just engineers, but the broad spectrum that is involved with public works as

03 TIPS FOR SUCCESS

- 1** Always be open to new opportunities.
- 2** Having broad experience is useful. Even if you don't think an opportunity will take you directly to where you want, you never know what it might lead to.
- 3** Being a generalist means that you can be very useful, very employable and don't get pigeon-holed into doing just one thing.



well. A lot of local government engineers and associated professionals are members of IPWEA," she explains.

"It's a great way to meet other people and hear about what's happening in other organisations."

This particularly matters in a small state like Tasmania.

"It's inevitable that you'll bump into people through multiple means within the general broader community, so it's nice to have those connections," she says.

"It's a great way to give back to the community."

Parnell is a Chartered engineer, and she believes that the accreditation will become more valuable in the future as more

jurisdictions require engineers to be registered.

"With more of a move towards registration and having various legislation around the place requiring certain proof of skill, it would definitely be useful having that already," she says.

She also appreciated the process of becoming Chartered, which helped her understand what made a well-rounded engineer.

"It's third-party proof that I've got what it takes to maintain my professional development and adhere to the code of ethics," she says. "It was quite a useful tool when talking with managers and going through my development agreements." ●



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Bede Mulholland
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Peter Thomson
Senior Civil Designer (MWH)

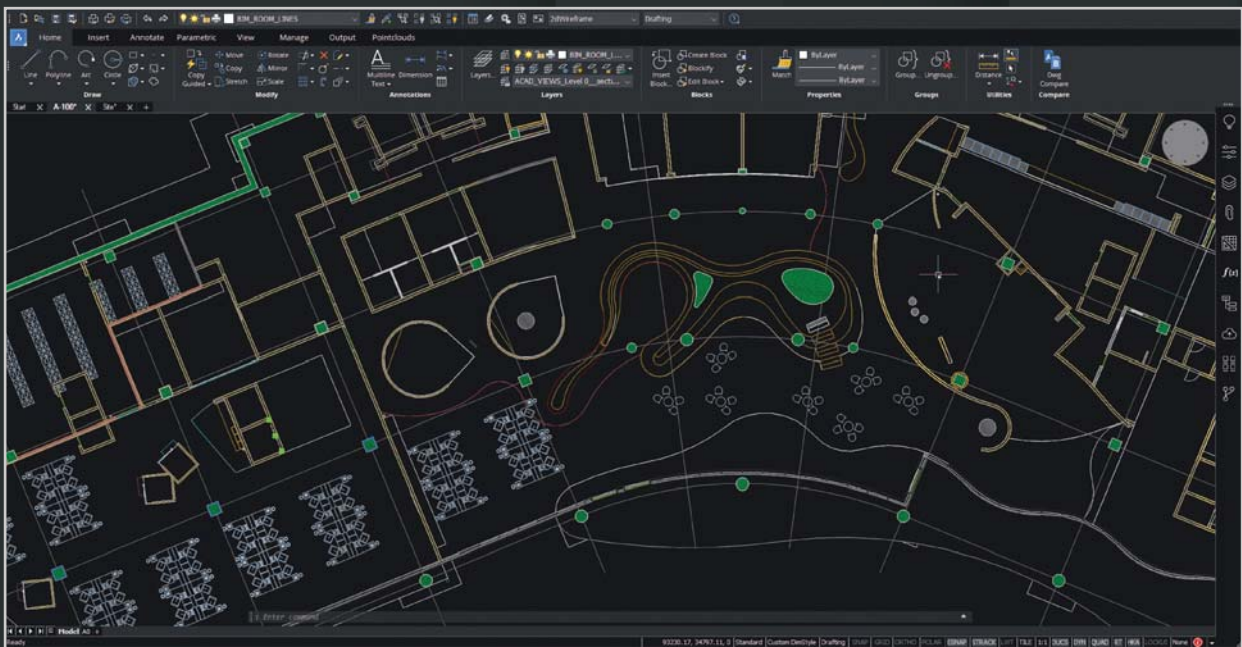
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