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## TIME TO SHINE

All eyes are on the engineering profession in a new brand campaign from Engineers Australia.

**Engineering. Making life happen.**

Showcasing engineering to inspire a new generation



ENGINEERS AUSTRALIA

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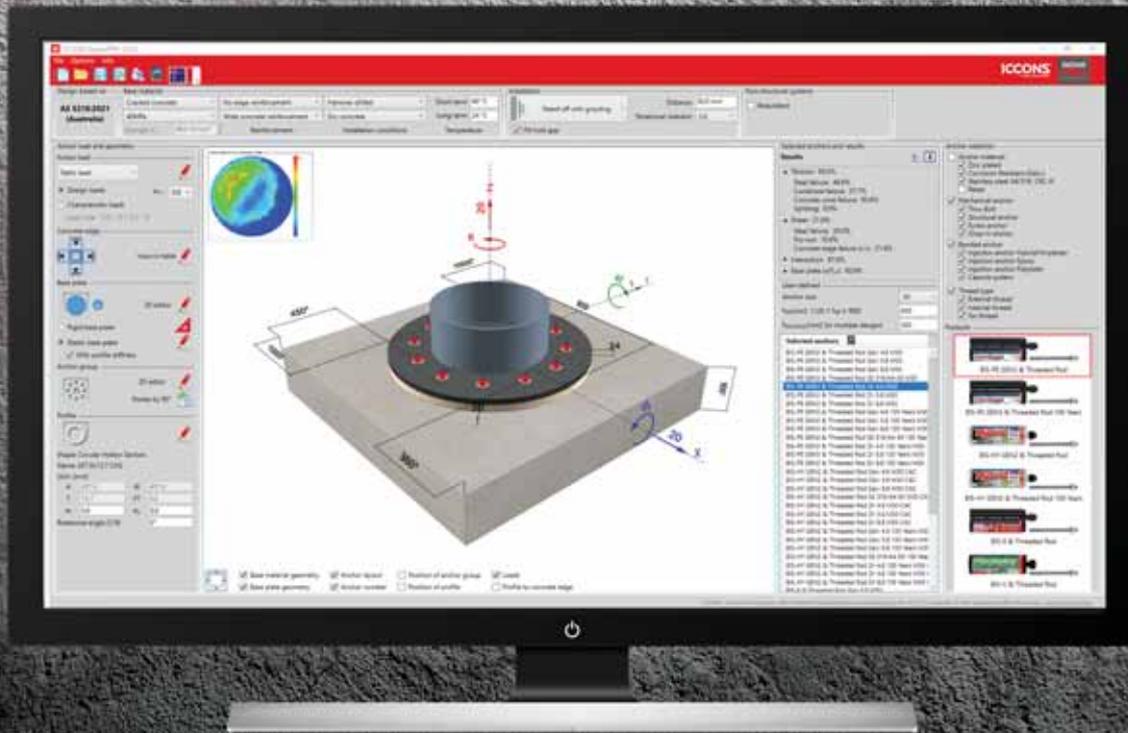
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12



**EVERY ISSUE**

**06** PRESIDENT'S AND CEO'S MESSAGE

**53** ENGINEERING TRENDS

**55** EVENTS

**56** TECH WATCH

**58** KEYSTONE

**NEWS**

**08 ROMILLY MADEW**  
Engineers Australia's new CEO wants to work as a strong advocate for the profession.

20

**ROBOTICS**  
The Australian company driving a drone revolution under the sea.



38

**PROJECT**  
Going deep with this year's winner of the Australian Construction Achievement Award.

46

**SEA ELECTRIC**  
Australia's first electric truck manufacturer hopes to make a difference on carbon reduction.



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FROM THE NATIONAL PRESIDENT  
& THE ACTING CEO

## Making life happen

ENGINEERS AUSTRALIA IS DRIVING A NEW CAMPAIGN THAT WILL BRING PUBLIC ATTENTION TO ENGINEERS AND THEIR ACCOMPLISHMENTS.

Welcome to the August issue of *create*. This edition showcases our new brand campaign, which you may have already seen on screens and billboards or heard on podcasts since it went live on 24 July.

Increasingly, we live in uncertain times, with unrest between nations and the effects of the COVID-19 pandemic and natural disasters being felt locally, in domestic and international markets, in supply chains, and in the very wellbeing of ourselves, our colleagues and our loved ones. But engineers shine in uncertain times and through change comes opportunity.

By increasing awareness of engineering, the brand campaign

in innovation and the evolution of technology to advance society. The profession is at the forefront of the battle to address climate change and a transition to a clean energy economy.

By amplifying the voice of the profession, we seek to give engineers a seat at the table in government and corporate policy making.

Our members told us they wanted to see a greater understanding of the work of engineers among wider society. This first phase of the campaign features real-life projects that move away from hard-hat and hi-vis stereotypes to help people understand that engineering is a diverse field made up of people from all walks of life.

An effective balance of cultural and gender diversity in engineering will strengthen the profession and ensure

#IAmAnEngineer challenge of posting a picture of yourself and your colleagues in your working day.

It might be on the job site, in a research facility, in the field or at your desk. You might be in a reconstruction zone after a fire, testing unmanned vehicles on an obstacle course, or creating urban habitat by turning a stormwater drain back into a creek bed. You could be at your computer at 4 a.m. after a eureka moment.

It's a great way to show the world the array of experiences a career in engineering offers.

In what is a busy time for Engineers Australia, we also welcome our new CEO, Romilly Madew AO FTSE HonFIEAust, who comes to us from Infrastructure Australia this month. You can read an interview with Romilly in this issue.

**“You can get involved in the campaign by sharing our posts on social media and taking up the #IAmAnEngineer challenge of posting a picture of yourself and your colleagues in your working day.”**

is one way Engineers Australia is building some surety for our profession. With the campaign theme “Engineering. Making life happen”, we are demonstrating how engineering touches all aspects of life, every day.

Engineers deserve greater recognition for their critical role

it is best placed to serve society now and into the future.

One aim of the campaign is to address the skills shortage in certain sectors. Advertising around universities and in high-profile television timeslots, streaming services and podcasts will encourage the next generation of talent to explore engineering as a career.

Get involved by sharing our posts on social media and taking up the



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# The change maker

ROMILLY MADEW IS TAKING THE REINS AT ENGINEERS AUSTRALIA AND HAS HER SIGHTS SET ON THE WORLD'S "WICKED" PROBLEMS.

A NATURE-BASED upbringing was crucial in shaping Romilly Madew's career: learning to sail at the age of eight, bushwalking holidays, traipsing around Guadalcanal on the Solomon Islands, ocean swimming all year round and climbing Mount Kilimanjaro with her family.

Madew has long demonstrated an unwavering interest in the environment.

"My interest in sustainability came from my love of nature and seeing the adverse impact of climate change," says Madew, the new CEO of Engineers Australia.

"I always wondered why we weren't doing something about this and fell into roles where I could have an impact, use my voice and be an advocate for change."

Madew has a strong familiarity with Engineers Australia, having interacted closely with the organisation for more than 20 years, especially while CEO of Green Building Council of Australia (GBCA) and subsequently CEO of Infrastructure Australia (IA).

Madew says she sees the engineering profession as the nation's problem solvers. She was also drawn to Engineers Australia's focus on big picture issues: climate change, integrated infrastructure planning, advanced technology skills and capacity challenges and diversity.

"I'm excited to work with highly intelligent and capable people in all the areas where Engineers Australia has impact. Engineers Australia is evidence-based and works closely with members. I'm

looking forward to working and learning from many of Australia's best and brightest," she says.

"I enjoy working with groups of people considering wicked problems, finding solutions and working through those solutions – and also executing them. It's about working collaboratively and considering what works and what doesn't."

The year 2005 was a pivotal one in Madew's career. After being seconded by her employer, the Property Council of Australia to GBCA in 2004, she became a consultant to GBCA in 2005 and spent the year researching and writing *The Dollars and Sense of Green Buildings*.

This landmark document, released in early 2006, outlined the business case for green commercial buildings in Australia.

"It filled a void in Australia" says Madew. "We first printed 1000 copies and then another 5000. In the end 20,000 were downloaded from the GBCA website in a short timeframe."

It was during her role at GBCA that Madew came to be known as a "changemaker".

"When the GBCA was established in 2002, it was this small organisation developing a rating tool called Green Star," says Madew. "At the time, I don't think we, as the industry, really appreciated the impact. Ten years down the track, the

impact of the work of GBCA was enormous, we were changing whole cities; changing the way the built environment was designed, operated and performed with sustainability at the forefront, both in Australia and globally."

The change did not come easily. At GBCA, Madew worked hard to transform mindsets within the industry and among stakeholders that green buildings didn't just help the environment but made good commercial sense

"We had to change the narrative and put it into financial terms – talking about value uplift, building performance, savings and productivity gains around a green building; people stood up and listened," she says.

Madew also attributes much of the success of sustainability in the built environment to the collaborative nature of the sector.

"I've yet to experience another sector that has collaborated like the built environment," she says. "Many of these collaborations were between engineers – all coming from different backgrounds and experiences – and even competitors. They would get into a room together and work out how to evolve Green Star, considering best possible outcomes around access to fresh air and daylight, incorporating recycled water, and reducing the impact of energy in a building."

RIGHT:  
Romilly  
Madew, CEO  
Engineers Australia.

**"I'M EXCITED TO WORK WITH HIGHLY INTELLIGENT AND CAPABLE PEOPLE IN ALL THE AREAS WHERE ENGINEERS AUSTRALIA HAS IMPACT."**

Madew wants to ensure that Engineers Australia can provide the policy and the advocacy, the continuing professional development, and the education to help engineers understand what a sustainability mindset is and how to incorporate it in the work that they do.

Madew saw opportunities to change the way buildings and communities are designed, built and operated. And this passion took her to Infrastructure Australia, which had just begun to focus on sustainability and resilience when she arrived in 2019.

Sustainable engineering will be a key focus for Madew as Engineers Australia CEO.

“We need to ensure that all engineers have a sustainability mindset in the work that they’re undertaking,” she says.

To drive transformation and embrace a sustainability mindset at IA, Madew worked with the team to consider how to incorporate it into the procurement process.

“We found that many of the infrastructure projects IA assessed did not consider the impact of climate change,” she says.

Madew is also a firm believer in strengths-based leadership, an area that IA focused on successfully.

“We found that focusing on people’s strengths and then complementing those qualities with someone else’s strengths created a more productive outcome,” she says.

Addressing the gender imbalance in engineering is another entry on Madew’s priority ▶



list and, to do so, she will draw on her experience in construction and infrastructure.

Madew says the Property Council of Australia has made headway with a range of programs, from mentoring to the Girls in Property program, which promotes property careers in schools.

"The 110,000 members of Engineers Australia can be a huge platform to support our advocacy in schools and universities," she says.

"We want girls to undertake STEM subjects, and attract them to engineering. When you consider that only 16 per cent of engineering students are women, we really can do better."

Engineers Australia has already made great strides in influencing

**"I WOULD LIKE TO SEE ENGINEERS AUSTRALIA AS ONE OF THE KEY STAKEHOLDERS THAT THE FEDERAL GOVERNMENT CONSULTS. OUR MEMBERS WILL BE AN INSTRUMENTAL PART OF HELPING US GET THERE."**

important government regulation, such as compulsory engineering registration in New South Wales and Victoria. Madew will draw on her vast experience at IA, a body that is heavily relied upon by the federal government, states and territories, as well as the industry, to further this work.

"It's important we not only talk to external stakeholders, but work closely with our volunteers and members, drawing upon their expertise and experience," she says.

Given the enormous and important work that engineers do, Madew believes the profession needs to have a bigger voice in significant national conversations, such as investing in Australia's engineering workforce and expanding sovereign capability.

RIGHT: Romilly Madew wants the engineering profession to have a bigger voice in important national conversations.



"I would like to see Engineers Australia as one of the key stakeholders that the federal government consults," she says.

"Our members will be an instrumental part of helping us get there".

She acknowledged the work already being undertaken by the Chief Engineer, Jane MacMaster, in elevating the voice of Engineers Australia with government.

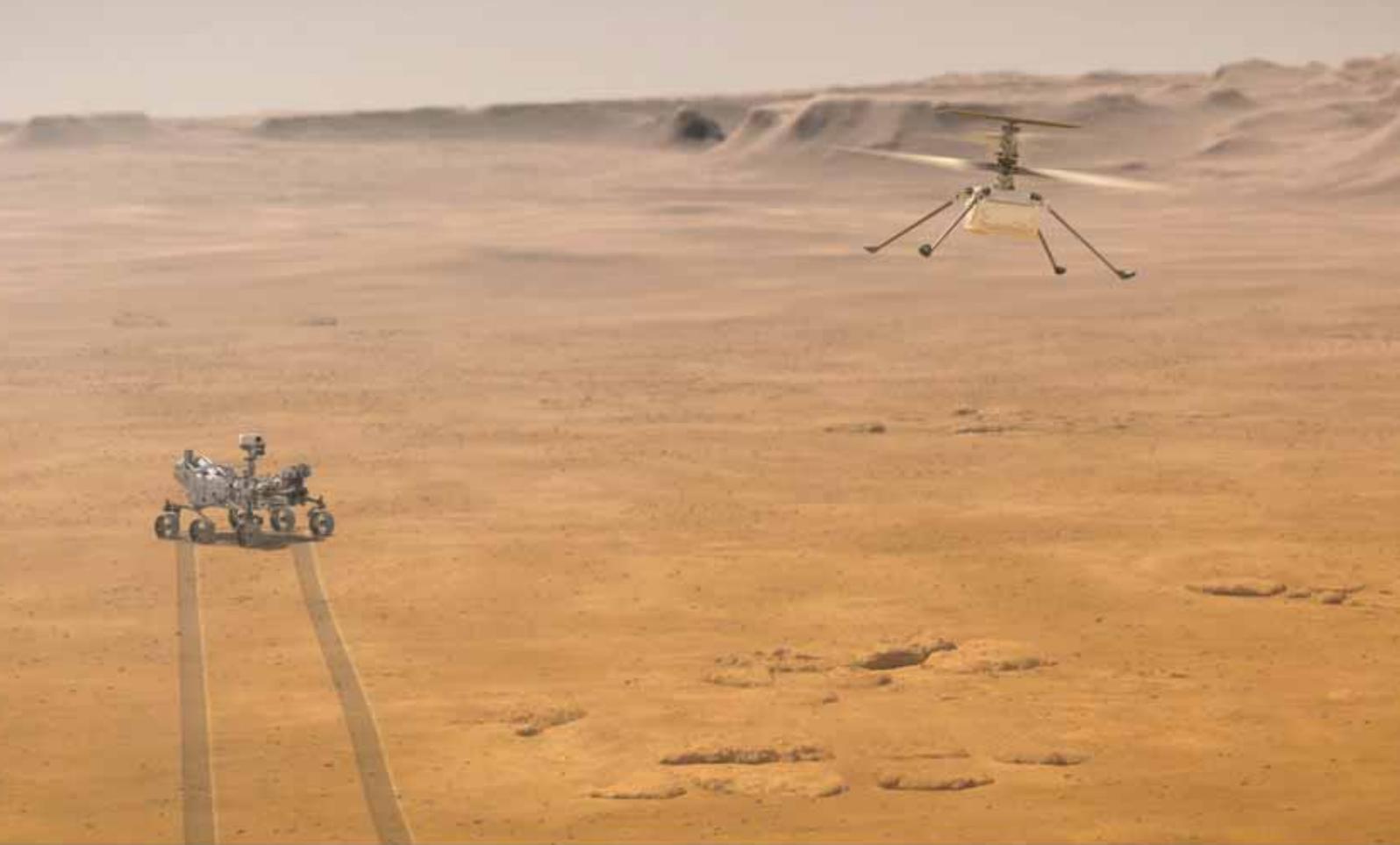
There are a lot of people jockeying for their voices to be heard, and Madew says she wants

to ensure that Engineers Australia is one of those voices.

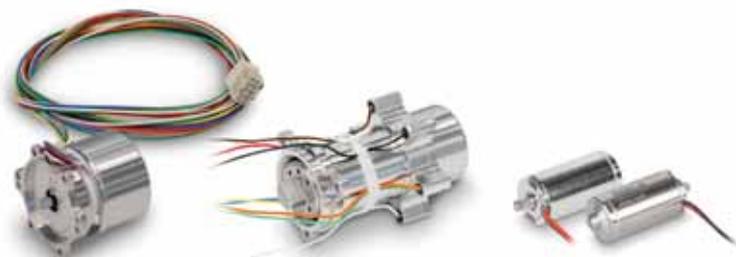
"Engineers Australia is very good at its internal voice and in sharing the great work it's doing with its members," she says.

"I will work closely with the team and our members to enhance our external voice. Engineers Australia has the noble goal of advancing society through great engineering and I'd like to see the organisation become an even stronger advocate for the profession." •

KEVIN GOMEZ



## maxon motors on Mars



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

### **Ingenuity Helicopter**

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

### **Perseverance Rover**

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

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Main Image Credit NASA/JPL-Caltech

WORDS BY KEVIN GOMEZ

# HELPING HANDS

BIOMEDICAL ENGINEER DR GOUGH LUI IS USING ELECTRONICS TO GIVE THE NEXT GENERATION OF SURGEONS “HANDS-ON” TRAINING.

**A**T SYDNEY'S Liverpool Hospital, trainees undergoing their surgical skills training were finding it challenging to put the feedback they received into practice.

The reason: mentoring over the shoulder.

An experienced surgeon would watch what the resident was doing and provide feedback.

However, this feedback was not specific enough to enable change or enhance the resident's skills.

The problem attracted the attention of Dr Gough Lui, a biomedical engineer at Western Sydney University and the “engineer-in-residence” at Liverpool Hospital.

Lui set about using his expertise to devise a solution that would augment traditional surgical training. He recognised that surgeons employ intricate hand movements and focused

on ways to track and measure these manoeuvres.

“There are virtual reality systems for surgical training but they're quite expensive and you're lucky if you are working at a hospital that has even one of them,” Lui tells *create*. “While simulators do provide some kind of automated feedback, it's not easy to understand and there is no graphical representation.”

The need for a simple-to-use system inspired Lui, supported by funding from the James N. Kirby Foundation, to work on a glove-based solution that focused on individual finger motions.

“We started by instrumenting the fingers with force-sensitive resistors so we could measure how they're squeezing on to the

tools that they're using,” says Lui. “We were interested in seeing how they were gripping the tool, how hard they were pushing on it, and whether they're going to snap the instruments.”

## SENSITIVE TOUCH

Lui initially placed the electronics on the back of the glove to detect acceleration and hand orientation, then added force-sensors to the fingertips.

“But experienced surgeons reported that the gloves reduced their touch sensitivity and were too bulky, hindering movement,” he says. For the next iteration, Lui removed the force sensors, opting for inertial measurement unit (IMU) sensors on the back of the hand.

A commercially available Bluetooth wireless unit sitting on ▶

**“WE WERE INTERESTED IN SEEING HOW THEY WERE GRIPPING THE TOOL, HOW HARD THEY WERE PUSHING ON IT, AND WHETHER THEY'RE GOING TO SNAP THE INSTRUMENTS.”**

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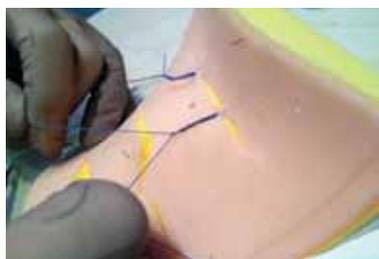


**“SOME OF THEM HAVE APPROACHED US AND SAID, ‘WE WOULD LIKE TO BE RECORDED BECAUSE WE WANT OUR HANDS AND OUR MOVEMENTS TO INSPIRE ANOTHER GENERATION OF SURGEONS.’”**

the back of the hand transmits the signals for capture and analysis.

“We don’t measure the finger-tip force now, but at least we have the posturing of the hand and the speed of rotation, of linear acceleration – that is quite useful,” Lui says. However, much of a surgeon’s dexterity and skill lie in their finger manipulation, and capturing this accurately was the next hurdle.

To do so, Lui relied on tiny nine-axis IMUs that combine three-axis accelerometers, gyroscopes and magnetometers. These are placed on thin flexible PCBs and embedded in the



ABOVE: Dr Gough Lui, Western Sydney University.

LEFT: An early prototype of Lui’s glove-based training tool.

glove so they lie on the back of each finger segment, recording measurements without hindering the surgeon’s movement or feeling.

“There is a wide understanding within the surgical fraternity that basic skills are perhaps more important than anything else,” says Lui.

A surgeon might need to change the way they operate for each patient because their body layout is a little bit different. The patient might be a distinct size and weight, for instance, or could have a tumour in an uncommon spot.

“Surgeons have to adapt to such unique situations for every surgery,” says Lui. “But for things like throwing a stitch, that is the same, and they will be doing it thousands of times – possibly even in a week.

“So, when you think of it over the full length of the surgical ▶

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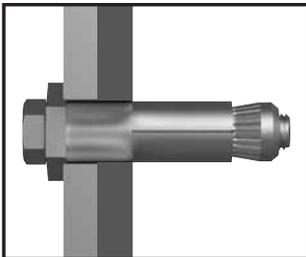
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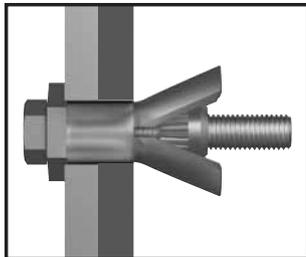
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career, some of these more basic skills are much more vital, and they've also been shown to be good indicators of the overall acquisition of higher-level skills. So, if you're good at the basics, generally you are good at the more difficult aspects."

That's not to say that dexterity is the only component.

"We are acutely aware that surgical skills also involve decision-making, and that's something that our system won't be able to teach you," says Lui. "But we feel that any contribution to this field is worthwhile, because a lot of trainees have complained that these skills are difficult to acquire, and they drop out."

This becomes an issue as experienced surgeons approach retirement age.

## "WE ALSO KNOW THAT NOT EVERY SURGEON DOES THINGS THE SAME WAY, SO WE ARE BUILDING A LIBRARY OF EXPERIENCED SURGEONS' MOVEMENTS."

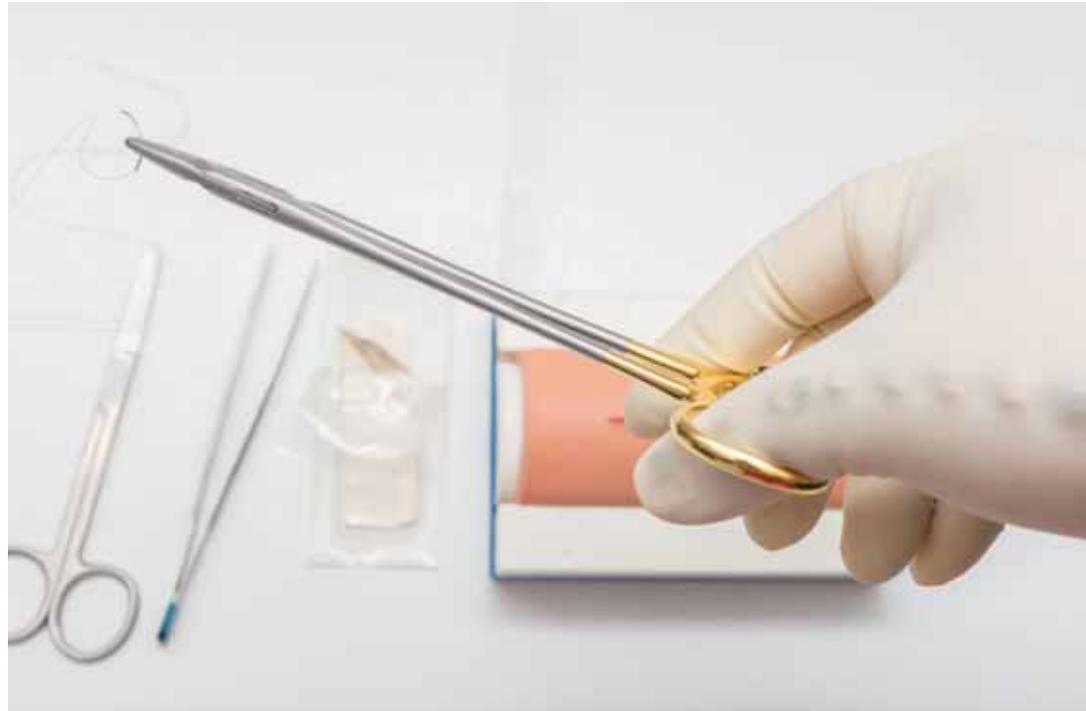
"They've developed these skills over 30 or 40 years and some of them have approached us and said, 'We would like to be recorded because we want our hands and our movements to inspire another generation of surgeons,'" Lui says.

The smart glove may make this possible and, in doing so, reduce the risk to and improve the outcomes of people operated on by younger surgeons.

### DATA COLLECTION

Since surgeons normally double-glove for infection control, Lui's system adheres to the back of an inner glove that goes over the hand.

PCB strips on the glove along the back of the thumb, index



ABOVE: The sensors are placed on the fingers to measure a surgeon's movements.

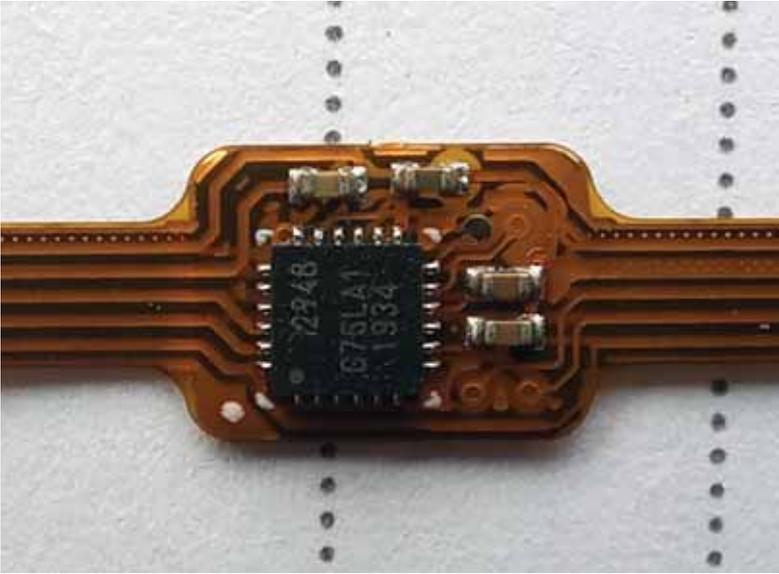
and middle finger lead to a motherboard resting on the back of the hand. The motherboard holds a rechargeable lithium-polymer pouch battery that powers an ESP32 microcontroller providing wireless connectivity. This flat assembly is then encapsulated in a second latex glove.

Each node in the electronics assembly has a nine-axis IMU and with three nodes on each finger, leading to 81 channels.

"That's quite a lot of data but, basically, each IMU is

providing three-axis acceleration, gyroscope, and magnetometer outputs," says Lui. "Later on, we transform that data into fewer channels and may even transform them into quaternions."

Quaternions are mathematical formulae used to represent an orientation in 3D space and are used in 3D game programming. "It's a little bit complicated, but there has also been interest in using AI," says Lui. ▶



## “THE CLOSE RELATIONSHIP BETWEEN CLINICIANS AND ENGINEERING RESEARCHERS HAS BEEN VITAL IN SHAPING THIS INNOVATION.”

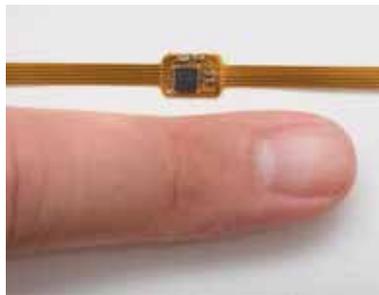
However, he is unconvinced about AI's benefits.

“I feel that there is a black box with AI and ‘explainability’ has always been a hurdle,” Lui says.

“You can train AI on data, and it will tell you ‘yes’ or ‘no’, but why is it a ‘yes’ and why is it a ‘no’? If we can’t work that out and communicate it to our trainees, we’re no better than the person watching over the shoulder saying that was good and that wasn’t good.”

So Lui is pursuing a different approach, looking at template-matching data analysis. His solution is to enable trainees to compare their movements with pre-recorded actions of experienced surgeons.

“We also know that not every surgeon does things the same way, so we are building a library of experienced surgeons’ movements,” he says.



“The trainee can then say, ‘Well, I want to be like that surgeon. I want to compare myself to them. How do they do it?’ And then see the difference in the way they are manipulating each part of their finger – and also their hand overall.”

Lui considers building the database of experienced surgeons as his most vital activity for now.

The other challenge is providing feedback during the surgery. Audio and haptic feedback can be distracting and builds dependence. Lui’s solution is to record the procedure and



ABOVE: Flexible PCBs hold the microcontroller, battery and sensors and line the backs of the fingers.

allow the surgeons to match their movement data from the IMUs, but also see visually what was happening to their hands.

“Sometimes it’s not intuitive looking at IMU data. What does a heading of 135 degrees or a rotation of 600 degrees per second actually mean?” asks Lui.

“But we can provide some guidance by actually showing them the visual difference as well.”

Chip shortages have delayed production, but Lui aims to trial the device by the end of the year.

“The close relationship between clinicians and engineering researchers has been quite vital in shaping how this innovation is moving, and also for us to have willing participants to trial our prototypes and be enthusiastic about it,” he says. •

### Skills transfer

Western Sydney University’s Dr Gough Lui did not always work in the biomedical space.

“Although I did my engineering degree in electrical engineering, specialising in photovoltaics and renewables, I ended up in civil and environmental for my PhD,” he says.

“There was a desire to use UV-C LED radiation to build water disinfection units for developing countries, but they had nobody in the civil and environmental school who understood embedded systems and electronics.

“The university felt it was easier to poach me because I had that background, and teach me how to do water research, rather than take someone from water and teach them electronics. I’m still working on this project part-time.

“I’m now growing those skills in the field of biomedical engineering.”



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WORDS BY JONATHAN BRADLEY

# HIDDEN DEPTHS

AUSTRALIAN ROBOTICS COMPANY ADVANCED NAVIGATION IS TRANSFORMING THE WORLD OF UNDERWATER DRONE TECHNOLOGY.

**T**HE CRAFT is a gleaming projection of smooth white plastic about the size of a vacuum cleaner. For the Hydrus, however, dust is not a concern.

This new creation from Australian artificial intelligence firm Advanced Navigation is designed for the oceanic depths.

Fully autonomous, programmable from out of the box, and able to venture 3000 m below sea level, the Hydrus is designed to transform what researchers and industry can do at sea.

“The drone revolution that we saw over the last 10 or 15 years on land - we wanted to take that same thing and do it under water,” Xavier Orr, Advanced Navigation’s CEO, tells *create*.



IMAGES: ADVANCED NAVIGATION

Kitted out with advanced sonar, navigation and communications systems, the Hydrus is able to undock itself from its resident home base and navigate autonomously, avoiding obstacles and adjusting missions on the fly.

The technology requires no specific knowledge or training to use and has a web interface that makes it simple to plan and execute underwater missions in three dimensions.

Equipped with a cinema-grade 4K 60 fps camera and an artificial intelligence engine, it can analyse image quality and adjust lighting in real time as it operates.

It is even compact and lightweight enough to be launched by a solo operator; Advanced Navigation boasts that it can be taken on to a plane as carry-on luggage.

### BACKYARD BUSINESS

The Hydrus follows a long career of engineering achievement for Orr, who began his first business

in high school after building a console for DJ equipment.

His own computer-repair enterprise followed soon after, and he could call himself the founder of two companies before he had even begun studying at university.

"I started that in Year 12 and it kind of took off quite quickly," he says. "I think we had six staff at the height of it, and then it was getting too hectic when I got to my final years and I had to kind of wind it down."

Orr studied mechatronics at the University of Western Australia, but says he has been interested in the ways different technologies fit together since he was a young age. It was a childhood hobby that sent him to hospital on one occasion.

"I was always interested in both sides of it – the electronics and the software," he recalls. "I used to like to take things apart as

a child. I almost badly hurt myself in a caravan – taking apart the caravan wiring and it was still connected."

### BACK TO THE '60S

The Advanced Navigation story starts in 2008.

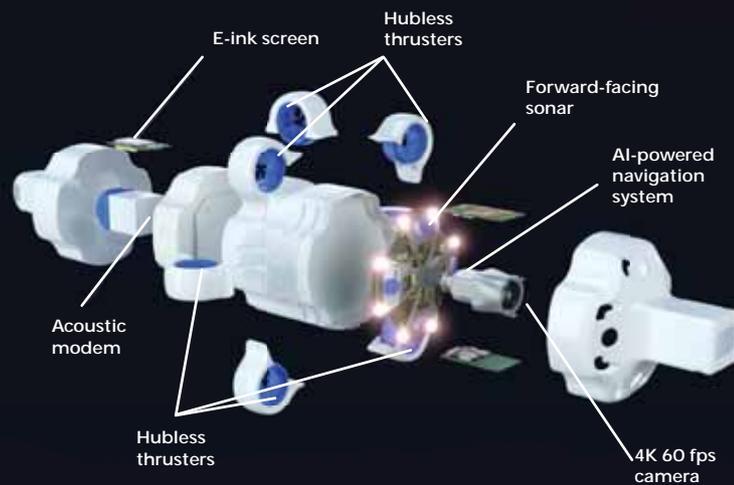
"I just finished three years of AI research at UWA over in Western Australia, and I was looking at algorithms and, in particular, the main algorithm that's used in navigation, which hasn't been updated since 1967," he says.

"I was really shocked at that ... Most algorithms get progressively updated over time, and this is an algorithm you'll find in your phone, in your house, in your car – it's everywhere. And so I did my thesis on the application of neural network AI to navigation."

Having launched his career by reinventing an algorithm that had been partially developed for the first moon landing, Orr began looking to commercialise his research. ▶

LEFT:  
Advanced  
Navigation's  
Hydrus drone.

## Introducing the Hydrus



**"THE DRONE  
REVOLUTION THAT  
WE SAW OVER  
THE LAST 10  
OR 15 YEARS ON  
LAND – WE WANTED  
TO TAKE THAT  
SAME THING AND DO  
IT UNDER WATER."**



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"I met my business partner, Chris Shaw. He was really specialised in sensors and microelectronics, which was the other piece of the puzzle to really put the company together," he says.

"So we joined forces to start Advanced Navigation in 2012, based on that thesis technology."

Orr and Shaw maxed out their credit cards to begin a company focused on autonomous systems.

"It was just me and Chris, so there was no one else really. We took out as many personal loans and credit cards as we possibly could and boot-strapped it that way," Orr says. "We were really fortunate that ... just before the money ran out, we started getting some decent volume orders in and really took off from there."

#### DIVING DEEP

From those nerve-wracking beginnings, Advanced Navigation expanded its range to encompass fields including underwater acoustics, global positioning systems, radio frequency systems, sensors and robotics.

Today, it supplies organisations including NASA, Airbus, Boeing, Tesla, Google, Apple and General Motors. It has sold to more than 70 countries, and has offices in Sydney, Perth, Canberra, Newcastle, California and London.



**"IT WAS JUST ME AND CHRIS, THERE WAS NO ONE ELSE. WE TOOK OUT AS MANY PERSONAL LOANS AND CREDIT CARDS AS WE COULD AND BOOT-STRAPPED IT THAT WAY."**

Inspiration for the drone came from the company's work with clients using underwater vehicles.

"We've been selling our sonar and navigation equipment to other underwater vehicles and they'll install that on their vehicles and go and operate missions," Orr says.

"And these vehicles will be huge - bigger than the size of [a] table, and it's a mix-and-match of parts off the shelf. So people will get a whole heap of bits and bobs and put it together on a vehicle. ►

ABOVE RIGHT: Advanced Navigation CEO Xavier Orr launches the Hydrus in Sydney.



#### Life at the top

As CEO of Advanced Navigation, Xavier Orr has to devote a lot of his attention to the business side of things. That doesn't mean he has abandoned engineering though.

"I'm definitely still quite involved with the products," he says.

"I'd say maybe 30 or 40 per cent of my time I'm still dealing with the products, but the actual engineering side of things is probably less. I'd still try and do a bit - five or 10 per cent of my time would go actually to doing product engineering and then maybe another 30 per cent or 40 per cent doing product management and the engineering vision.

"The more in-depth you are with your products ... the better the products are going to be that you're putting out."

“And they’re very difficult to use. They need huge ships, large crews; it’s a very expensive game to be putting those out and actually operating them.”

Orr decided there had to be a better way to do it.

“We wanted to take all of that technology that’s usually the size of a table and pack it into a tiny little vehicle that could be hand-deployed and deployed from anywhere and by anyone,” he says.

BELOW:  
Assigning the  
drone to navigate  
a preset path.

The resulting drone has a broad variety of uses.

“Surveying wind farms, offshore wind farms,” Orr offers as an example. “Another one is there’s a company trying to do underwater mine detection and classification – trying to identify if there are mines under water so that they can clear them and get rid of them.”

The accessibility of the technology might be why it can be adapted to so many situations: it can be operated via a web browser on a laptop, which connects to the Hydrus’s wi-fi.

“Then you can draw on the map where you want it to go, what depth you want it to go to. If you want it to look for certain things, follow a diver, it’s got a whole range of pre-programmed things you can make it do,” Orr says.

Orr compares it to using Google Earth or Google Maps.

“Without any training or any knowledge at all, most people

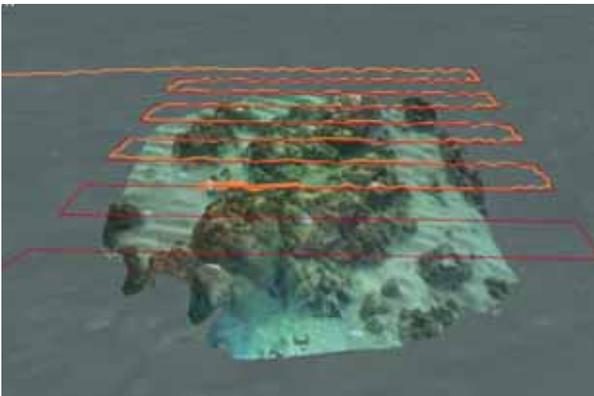
would be able to create a track and it would be able to just go,” he says. “They throw it in the water, it goes and completes that and comes back.”

#### PACKED TIGHT

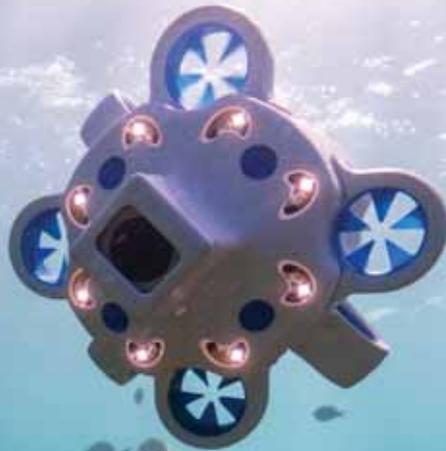
Developing the drone involved some notable challenges.

“Packing that technology into such a small size – there are some significant challenges with that,” Orr says. “The way we actually build the vehicle is completely different to the way any underwater vehicles are built right now. There are actually no air cavities. Right now, most underwater vehicles have a pressure vessel and there’s air and electronics contained in there.

“We went with a different methodology where there’s no air. Instead it’s plastic-moulded in and around everything – which allows ▶



**“WE WANTED TO TAKE ALL OF THAT TECHNOLOGY THAT’S USUALLY THE SIZE OF A TABLE AND PACK IT INTO A TINY LITTLE VEHICLE THAT COULD BE DEPLOYED FROM ANYWHERE AND BY ANYONE.”**



# Engineering challenges on offer at Territory Generation



*“At Territory Generation, we pride ourselves on excellence. A highly capable and innovative engineering workforce is critical to support our delivery of service as the Territory’s trusted and respected energy services provider,”*

– Gerhard Laubscher,  
Chief Executive Officer

**Territory Generation is the Northern Territory’s largest electricity producer, and we are committed to supporting government renewable energy targets.**

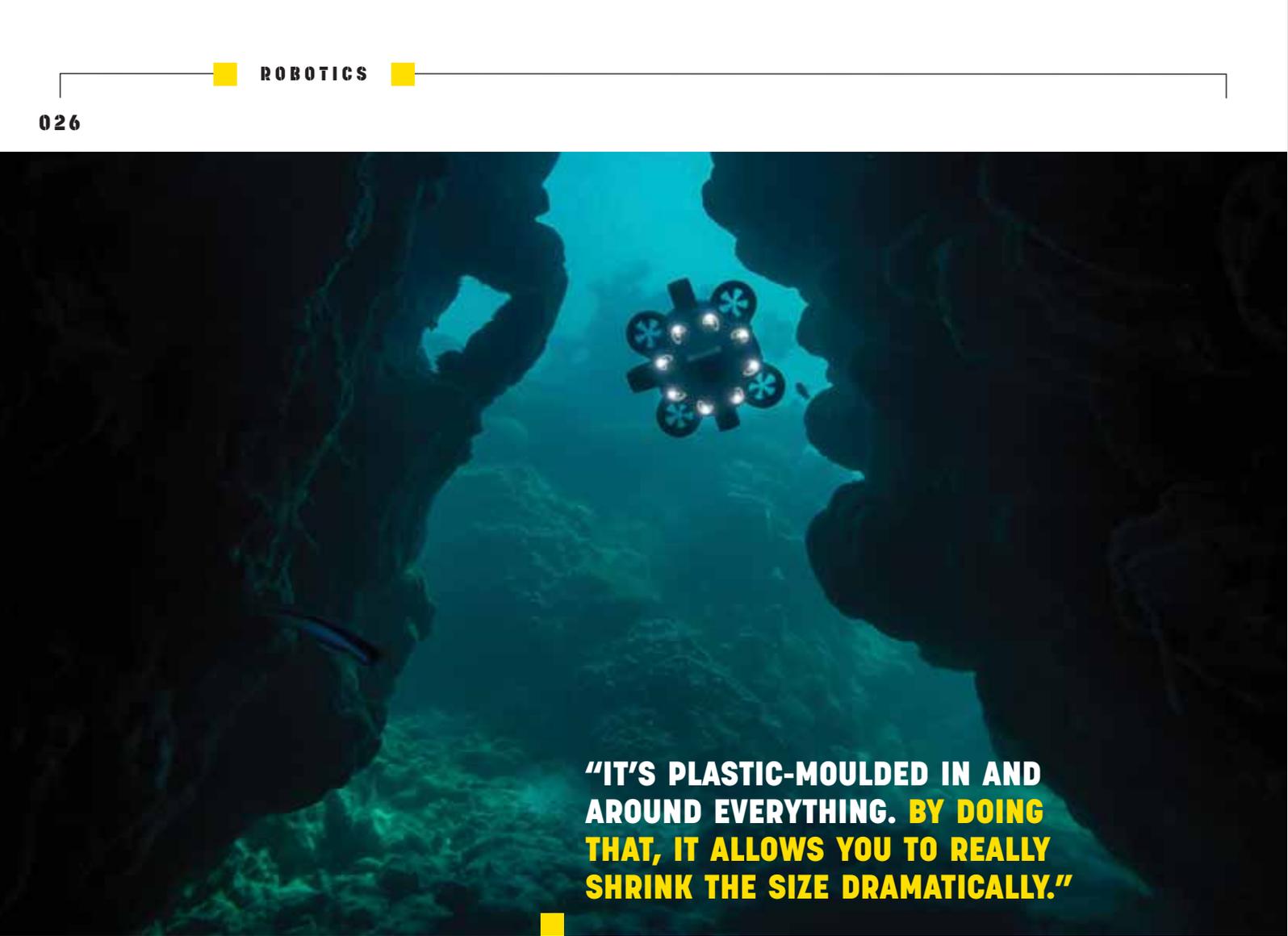
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- \* **Yulara Energy Transition Initiative:** delivering cleaner, lower-cost power to the Yulara resort and community
- \* **Microgrid feasibility studies:** investigating sustainable and resilient electricity supply options in the remote tourist hubs of Yulara, Kings Canyon and Tennant Creek
- \* **Alice Springs Future Grid:** collaborating as a project partner to identify and overcome barriers to further renewable energy penetration in the Alice Springs electricity system
- \* **Central Australia power supply project:** constructing 10.7 km of dedicated transmission line and a new 66/11kV substation
- \* **Fuel assessment and testing:** determining the capability of our generation fleet to utilise different fuels sources for maximum efficiency
- \* **Renewables:** integrating renewable generation into the Territory’s power systems



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**“IT’S PLASTIC-MOULDED IN AND AROUND EVERYTHING. BY DOING THAT, IT ALLOWS YOU TO REALLY SHRINK THE SIZE DRAMATICALLY.”**

us to ensure the whole system is pressure tolerant. By doing that, it allows you to really shrink the size dramatically.”

Advanced Navigation Mechanical Engineer Nikki Staltari says that adapting to an underwater environment required a significant change in her thinking. Many solutions that would make sense out of the water had to be completely reimagined for an aquatic environment due to the high levels of water pressure and lack of atmosphere.

“That was one of the biggest pivots I had to do for designing, in a mechanical sense,” she tells *create*. “All of your material choices, air bubbles, manufacturing techniques, buoyancy – everything is tested in your mechanical toolbox in your head.

“You can’t rely on some materials that you usually go to, because

they’ll corrode, or they won’t satisfy the pressure requirements that the Hydrus will be subjected to. We even have to consider some materials with specific acoustic profiles, because that’s how the vehicle positions itself.”

The craft’s size also shaped the team’s approach.

“You can’t use what the normal subsea industry would use – you have to pick and choose what properties they use and apply it in a different miniaturised way in Hydrus,” Staltari says.

“It really pushes you to think outside the box for a lot of things. Because we don’t have that luxury of space, you have to get really creative, and use up every inch of the Hydrus in a really clever way.”

One particular innovation that Orr points to is the Hydrus’s

thrusters – the tiny propellers that move it through the water.

“Everything that we looked at that was on the market that we could find, it just wasn’t really suitable,” he explains. “They’d all get jammed; they couldn’t handle continuous salt water. You had bits of debris come in and that would jam them up or sand would get into them. So we decided after about a year of trying to make things work off the shelf or from various suppliers that we would actually design our own thruster.”

The team took an entirely new approach, Orr says.

“We’re now looking at patenting that technology for the thrusters,” he says.

Staltari was part of the team that worked on the thrusters.

“We tested something that we thought was a bit of a crazy idea and we managed to get it to work,” she says. “The hub-less ▶

**ABOVE:**  
The Hydrus can venture 3000 m beneath the ocean.  
**BELOW:** Nikki Staltari, Advanced Navigation.



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





LEFT: The Hydrus can be launched by a single operator. BELOW: Programming a mission for the Hydrus.

propeller means that it's safe for wildlife, or safe for sea life."

Staltari came to Advanced Navigation after developing her talents in a completely different arena: the competitive world of motor racing. Unexpectedly, this proved good training for the work she would do on the Hydrus.

"In the motoring world, a lot of things were bespoke. That was what put you against your competition - if you could think or design a better solution for something, you're probably going to get the upper edge on them," she says.

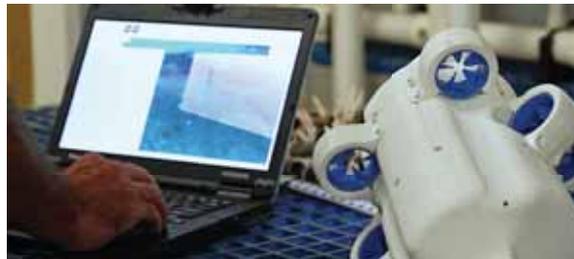
She also drew on her experience to adapt to working with the Hydrus's robotics and navigation functions.

"I was a data engineer with V8 Supercars, so I did have some exposure to electronics and sensors and calibrations in that field, as well as designing engine components," Staltari says. "Although a lot of the robotics that we work with are so high-end, I do find myself picking and choosing bits from my previous experience where I can draw on some of the robotics principles."

### MARINE RESEARCH

One exciting potential use for Hydrus is sustainability research.

The philanthropic Munderoo Foundation is intent on using the device to gather information about underwater ecosystems and using it to protect coral reefs from climate change induced damage.



**"HYDRUS IS ONE WAY OF SUPPORTING OUR MARINE RESEARCHERS AND SCIENTISTS TO ACCESS CUTTING-EDGE TECHNOLOGY WHICH PUTS THEM AT THE FOREFRONT OF TACKLING THE GREATEST THREATS TO OUR GLOBAL OCEAN."**

"Munderoo Foundation has made a strategic investment in this program as part of its mission to engage the best science and latest technologies in support of ocean conservation" says Dr Tony Worby, Munderoo's Director of Flourishing Oceans and the Planet Portfolio. "Having technology like Hydrus is one way of supporting our marine researchers and scientists to access cutting-edge technology which puts them at the forefront of tackling the greatest threats to our global ocean."

Orr says Munderoo has been doing a number of surveys on Western Australia's Ningaloo reef.

## To the moon

This past July, Advanced Navigation announced that a company it had acquired in May, Vai Photonics, would see its technology put to use in NASA's next voyage to the moon.

"Vai's been working on a technology for the last 15 years and it's a really specialised laser technology," Xavier Orr tells *create*.

"No one else can do what they're doing and they have the patents on the technology as well."

The technology takes in a large amount of information about a vehicle's surroundings.

"Landings right now are very risky," Orr says.

"There's no more worrying about that. Before it's landed, it can tell you if the surface is suitable to land on, [if] you're coming in at the right speed and angles and everything. All of that extra data and information you get really takes all the risk out of the landing."



"[It] is leading into the Flourishing Oceans initiative, which was [Munderoo founder] Andrew Forrest's thesis at university, where he's really wanting to gather data on the oceans to try and help restore them to their healthy state. And so the Ningaloo reef is the pilot program," Orr says.

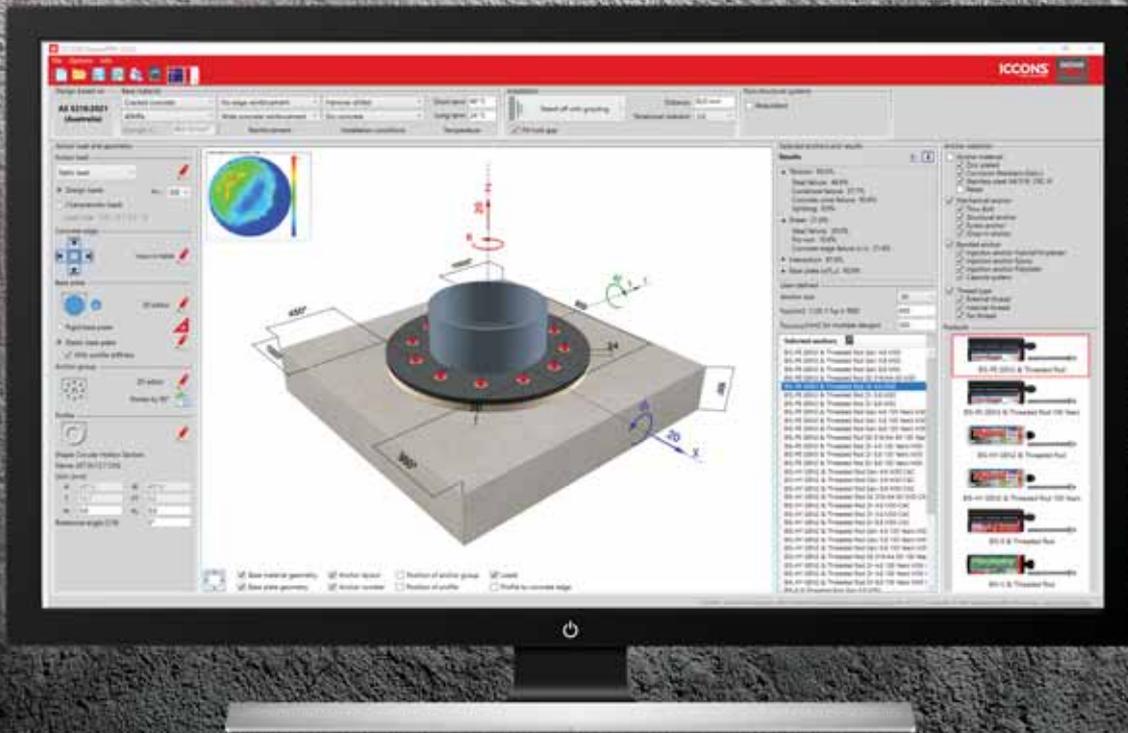
"We've got ... three of our team members up there with them this week. So, it's quite a close partnership where we're assisting their scientists to really maximise the way they can use the product." •

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WORDS BY RUTH COOPER

# Spotlight

ENGINEERS ARE WELL AWARE OF THEIR VITAL ROLE IN SOCIETY, FROM ADDRESSING GLOBAL CHALLENGES TO MAKING LIFE BETTER FOR LOCAL COMMUNITIES. A NEW PROGRAM FROM ENGINEERS AUSTRALIA AIMS TO SHOWCASE THIS WORK TO THE BROADER PUBLIC.

**I**N THE century that Engineers Australia has served its members, engineering has evolved. New disciplines, perspectives and ways of thinking have emerged to create a truly dynamic profession that has a tangible impact on the lives of all Australians.

But despite the transformative nature of their work, when asked to describe an engineer, many people still point to the stereotypical hard hats and hi-vis vests.

Much of the public lacks understanding about the profession's depth and breadth, and that engineers develop solutions and solve problems.

Often, engineers are tackling challenges those outside of the profession haven't thought of, such as managing fine motor manual tasks in extreme locations

like space or the sea floor, or predicting where an artery may fail in a cardiac patient.

In response to this, and drawing on input from members as part of its brand research, Engineers Australia is launching its first integrated, national brand campaign to showcase the pivotal work of engineers across mainstream print, television and social media.

It will tell the story of different engineering projects to show that the profession is much more than buildings and bridges – it includes everything from robotics in surgery and pumped hydro electricity generation to micro-recycling and soaring structural feats like a cliff-top walk and a modular construction high-rise.

## MAKING AN IMPACT

Nada Jolic, Engineers Australia General Manager Brand, Marketing and Communications, says the campaign will show how engineers make an impact in real life.

“Our members asked us for an advocacy campaign that highlights what a progressive, society-advancing profession engineering is,” she says.

“The campaign will raise awareness and understanding

of the value of the engineering profession, what engineering is today and how engineering improves the world around us by improving people's lives.

“It will be an uplifting, inspiring message that engineers can take pride in, and will elevate the status of engineering in the hearts and minds of the public.”

With its purpose of “advancing society through great engineering”, Engineers Australia advocates for the effective resolution of some of the most pressing issues facing the nation and the world. To do that, it must also help secure the next generation of engineers, attracting the nation's best and brightest by generating greater awareness of what engineers do.

Australia will need an estimated 100,000 extra engineers to cover proposed projects out to 2030, and this new campaign will help recruit the next generation of talent into the profession. This is vital for Australia's sovereign capability and capacity to tackle the challenges of managing the clean energy transition.

“By enhancing the profile of the profession, we are effectively amplifying the voice of engineers and giving them a seat at the table ▶

**“WE WANTED TO DEVELOP A PROGRAM THAT SHOWS HOW ENGINEERING TOUCHES THE LIVES OF PEOPLE IN PRACTICAL AND POWERFUL WAYS EVERY DAY.”**

PICTURED: A new Engineers Australia campaign showcases the pivotal work of engineers.



of government and corporate decision-making,” Jolic says.

#### LEADERS AND INNOVATORS

“From speaking with our members, it became clear that, although we know engineers are leaders and innovators, it’s not always clear to the general public,” says Dr Nick Fleming FIEAust, Engineers Australia National President and Board Chair.

“We wanted to develop a program that shows how engineering touches the lives of people in practical and powerful ways every day. Engineering is so pervasive that it’s almost invisible. It’s time for engineers to stand up and for engineering to stand out in the public and national interest.”

Through powerful storytelling, Fleming says, the campaign will help elevate the profile of ►



ABOVE (from top): The campaign emphasises the variety of ways engineers have an impact on the world; Nada Jolic, Engineers Australia.

## “IT’S TIME FOR ENGINEERS TO STAND UP AND FOR ENGINEERING TO STAND OUT IN THE PUBLIC AND NATIONAL INTEREST.”

#### HOW YOU CAN GET INVOLVED

# 1

Use your own social media channels to amplify the brand message.

# 2

Share Engineers Australia’s posts and embrace the use of the key brand message, “Engineering. Making life happen”.

# 3

Use the hashtag #IAmAnEngineer to share engineering content on your own social profiles. This could be a snapshot of your work day or a story about your career that reiterates the message that engineering has huge breadth and depth and can look like many things.



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LEFT: The campaign will feature in print, television and social media, as well as billboards, as seen in this artistic representation. BELOW: Engineers Australia National President Nick Fleming.

“Engineers have a unique way of seeing the world. They are the ones who can creatively solve the challenges of today and tomorrow. Because of them, nothing is impossible – it just hasn’t been done yet. This is what we want all Australians to know.”

Along with the advocacy campaign, members can also expect a reinvigorated website, which launched in July, and updated branding and imagery that reflects Engineers Australia’s bold identity as an organisation. •



## “IT WILL CONNECT THE AVERAGE AUSTRALIAN WITH THE POWER AND POTENTIAL OF ENGINEERING, SHOW HOW GREAT ENGINEERING MAKES PEOPLE FEEL, AND FUEL GREATER RESPECT FOR ENGINEERING.”

engineers, along with Engineers Australia as a recognisable and trusted representative of the engineering profession.

“It will connect the average Australian with the power and potential of engineering, show how great engineering makes people feel, and fuel greater respect for engineering and the aspiration to be an engineer,” he says.

“It’s another step in Engineers Australia and our profession making a proactive contribution to creating the world we want to live in.”

### ADVANCING SOCIETY

Jolic says she hopes the campaign will galvanise all engineers to

join Engineers Australia and be part of the movement to create safe, sustainable, healthy and prosperous societies.

The campaign tagline is “Engineering. Making life happen.”

“Great engineering advances society and Engineers Australia is the home of all engineers,” says Jolic.

### WHERE WILL YOU SEE THE CAMPAIGN?



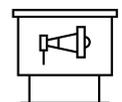
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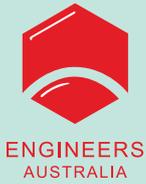


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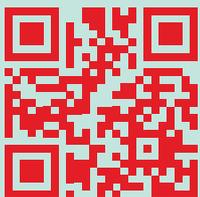
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WORDS BY CHRIS SHEDY

THE ENGINEERING MASTERPIECE THAT TOOK OUT AUSTRALIA'S TOP CONSTRUCTION AWARD REQUIRED AN ALMOST UNIMAGINABLE LEVEL OF PLANNING PRECISION AND ENGINEERING DEXTERITY.

**T**HE STANDOUT feature of the project that kept Terry Sleiman and 11,000 other engineers and contractors busily burrowing under central and suburban Sydney for four years was the infrastructure they had to avoid along the way.

"From an engineer's perspective, this job was like threading the eye of a needle – when you consider its complexity," Sleiman, Executive Project Director at CPB Contractors, tells *create*.

"The structures we had to avoid – the foundations, the existing infrastructure, the Cross City Tunnel, the old sewer tunnels, Telstra infrastructure, Tank Stream, station boxes at Martin



ABOVE: Terry Sleiman, Executive Project Director at CPB Contractors.  
BELOW: Blues Point Kathleen TBM Shield Retrieval.

Place, the footing of the Macquarie Bank building, which was literally two-and-a-half metres from where we were tunnelling – that all made it a standout for me.

"It was incredible. When we first realised the complexity, we said, 'You want to build what?'"

That "what" was the Sydney Metro City and Southwest Tunnel and Station Excavation Works, a joint venture between John Holland, CPB Contractors and Ghella.

Winner of the 2022 Australian Construction Achievement Award (ACAA), the project includes a 15.5 km twin rail tunnel, dive structures and six complex underground stations between Chatswood and Sydenham, including the first rail tunnels under Sydney Harbour.

The project was delivered below some of the busiest parts of Sydney's CBD, including Pitt Street and Martin Place.

#### TECHNICALLY PERPLEXING

There were two major challenges of the project. One was the technical complexity of running

# THREADING THE NEEDLE





## “WHEN WE FIRST REALISED THE COMPLEXITY, WE SAID, ‘YOU WANT TO BUILD WHAT?’”

tunnel boring machines (TBMs) for 15.5 km under heavily populated residential areas, a busy CBD and under a world-famous harbour.

“When we were metres away from foundations of buildings and other tunnels, I was thankful that Sydney has good tunnelling ground,” Sleiman says.

CLOCKWISE (from top): Barangaroo TBM 5 Cutterhead; Martin Place South; Barangaroo Station Box.



“You’ve got predominantly great-quality Hawkesbury sandstone for the majority of the tunnel alignment.

“It’s just when you start to get close to existing infrastructure, for example the Cross City Tunnel, things become challenging. At the closest, we were eight metres away from the overtop of the Cross City Tunnel, so we were literally

on top of it. We had to build monitoring instrumentation to go into that tunnel to monitor for any small movement.”

Engineers also had to design and build bridging slabs to ensure the ground above the Cross City Tunnel would not just ultimately handle train loading once the structure was complete but could also cope with the weight of the TBM – all 900 t of it, with a length of 140 m.

Beneath Martin Place, the team dug a station box just metres away from the granite-clad, heritage-listed Macquarie Bank building, which is more than 100 years old.

“We all know granite doesn’t take kindly to movement,” Sleiman says.

“And in the Macquarie Bank building, with its ornate ceilings... I don’t think we’ve even got the tradesmen to be able to recreate those ceilings should something have happened. It’s one of those lost arts. So yes, we had to be very careful.” ▶



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on this project was vital, Sleiman says.

For example, the Victoria Cross cavern is one of the largest caverns in the Southern Hemisphere. Much of the formwork, which was produced by Italian specialists to allow caverns to intersect with pedestrian access points, was the first of its kind. This was designed initially in a digital model to see how it might all fit together.

Not everything was imported, though. As the five TBMs cut through the rock, they also installed a tunnel lining made up of pre-cast concrete segments.

Six segments, each 1.7 m in length, make up one ring, with the



**“WHEN YOU TAKE OUT A CHUNK OF ROCK, THE GROUND AROUND IT RELAXES A LITTLE. IT RELEASES STRESS. THAT COULD MOVE FOUNDATIONS TO THE TUNE OF 40 OR 50 MM.”**

Of course, there was just as much concern about the surrounding modern, glazed buildings.

“They also don’t take kindly to movements in their foundations,” Sleiman says. “When you’re boring below or next to a building in Sydney, through sandstone, what happens is a phenomenon known as stress relief.

“When you take out a chunk of rock, the ground around it relaxes a little. It releases stress.

CLOCKWISE (from top): Victoria Cross North; Metro 2 Martin Place; Victoria Cross TBM Mabel breakthrough.



That could move foundations to the tune of 40 or 50 mm. The last thing you want is the glazing to start falling off.”

How did the team overcome such a high-risk challenge?

The solution was found in constantly updated 3D digital modelling of the entire site, so project leaders were certain of what would happen before the work even began.

This was complemented with a sophisticated monitoring program. Digital engineering

finished tunnel created as one ring after another was put in place. The almost 100,000 segments were produced in the Sydney suburb of Marrickville in a bespoke facility set up for this project.

“We take great pride in the labour force that was mostly unskilled, and who we trained on-site,” Sleiman says.

“It creates new skills and career development in a sector that urgently needs talent.” ▶



The other big challenge was onboarding the many communities that could be affected by the project. The tunnels would run under numerous suburbs and business districts, including much of Sydney's North Shore and through to the central business district. Thousands of houses, buildings, families and businesses could be affected.

Sleiman's team did all they could to minimise that impact.

"Doing the job in someone's backyard without impacting them at all was a big positive for me," he says.

"We undertook a significant condition survey program - in excess of 7000 properties. We took photos and provided these reports to property owners. This ensured everybody was happy that

ABOVE: Barangaroo TBM Kathleen front shield. RIGHT: Crows Nest nozzles.



**"WE HAD HUNDREDS OF PEOPLE COME DOWN AND ENJOY WATCHING OUR FINAL TBM BREAK THROUGH. THAT'S WHAT HAPPENS WHEN YOU'RE HONEST, YOU'RE UPFRONT AND YOU LISTEN."**



the reports were representative of the condition of properties. We explained that if any cracks prevailed because of the work, we would be here to fix them.”

After the work was done, the team conducted post-work condition surveys and once again offered those reports to residents and business owners.

“We had very few people come back to us and say they had any cracking,” Sleiman says. “Feedback said people really

TOP: Blues Point Marine Works.

supported the project because we supported them.”

A case in point was the building of a deep shaft in Blues Point Reserve by Sydney Harbour.

“Surrounding residents weren’t particularly enamoured with the idea of the reserve becoming a construction site, and a large shed to control noise that would block their prime harbour views for a period of time,” he says.

“But again, we got them on board early. We were honest about what we were going to build and

why, the timeline, what noise they could expect. So much so that for the final TBM breakthrough we put a big video screen up in that reserve. We got a coffee truck. We put some fliers around the neighbourhood. We had hundreds of people come down and enjoy watching our final TBM breakthrough. That’s what happens when you’re honest, you’re upfront and you listen.”

It’s little wonder that Jon Davies, CEO of the Australian Constructors Association, was so impressed with the project.

“This year’s winner delivered several Australian firsts that would not have been possible without the one team culture established from the outset,” he says. “All finalists have demonstrated that our industry is at its best when it works together.”

Engineers Australia Chief Engineer Jane MacMaster says the achievement is an example of the incredible results that can be achieved on a project of this size and complexity.

“In particular, embedding digital models and analytical techniques supported the project to achieve its impressive outcomes,” she says.

“Truly inspiring.” ●

## ROLLING IN THE DEEP

**One of the many firsts on the Sydney Metro City and Southwest Tunnel and Station Excavation project was tunnelling in the seabed, which required taking a tunnel boring machine to a place it had previously never been. Terry Sleiman talks *create* through the process.**

“We had to begin by developing a clear understanding of what the seabed looked like, particularly in the deepest parts. Once we started digging in the seabed, we reached a point where we were 40 m below sea

level, making it hyperbaric work, or work under pressure.

“The type of machine we used in Sydney Harbour was called a slurry TBM. At the face of the TBM we’d pump slurry to make sure that the material it’s digging through doesn’t fall back into the tunnel – like when you’re playing at the beach and the wet sand wants to keep collapsing back into the hole.

“That’s exactly what happens with the TBM. You’re drilling into material that is so wet, it just wants to collapse into the machine. So we use slurry to maintain pressure that pushes

against the wet sand. The other massive challenge is that you’re digging blind.

“When you’re digging through sandstone, you can pull the machine back a metre and physically see the stone. You don’t have that luxury in the seabed. We had to rely completely on the machine’s telemetrics to tell us what was going on.

“It’s slow and steady. With hard-rock tunnelling you can perhaps achieve 35 m per day.

“In the Sydney Harbour seabed we dialled it down to about ten metres per day.”





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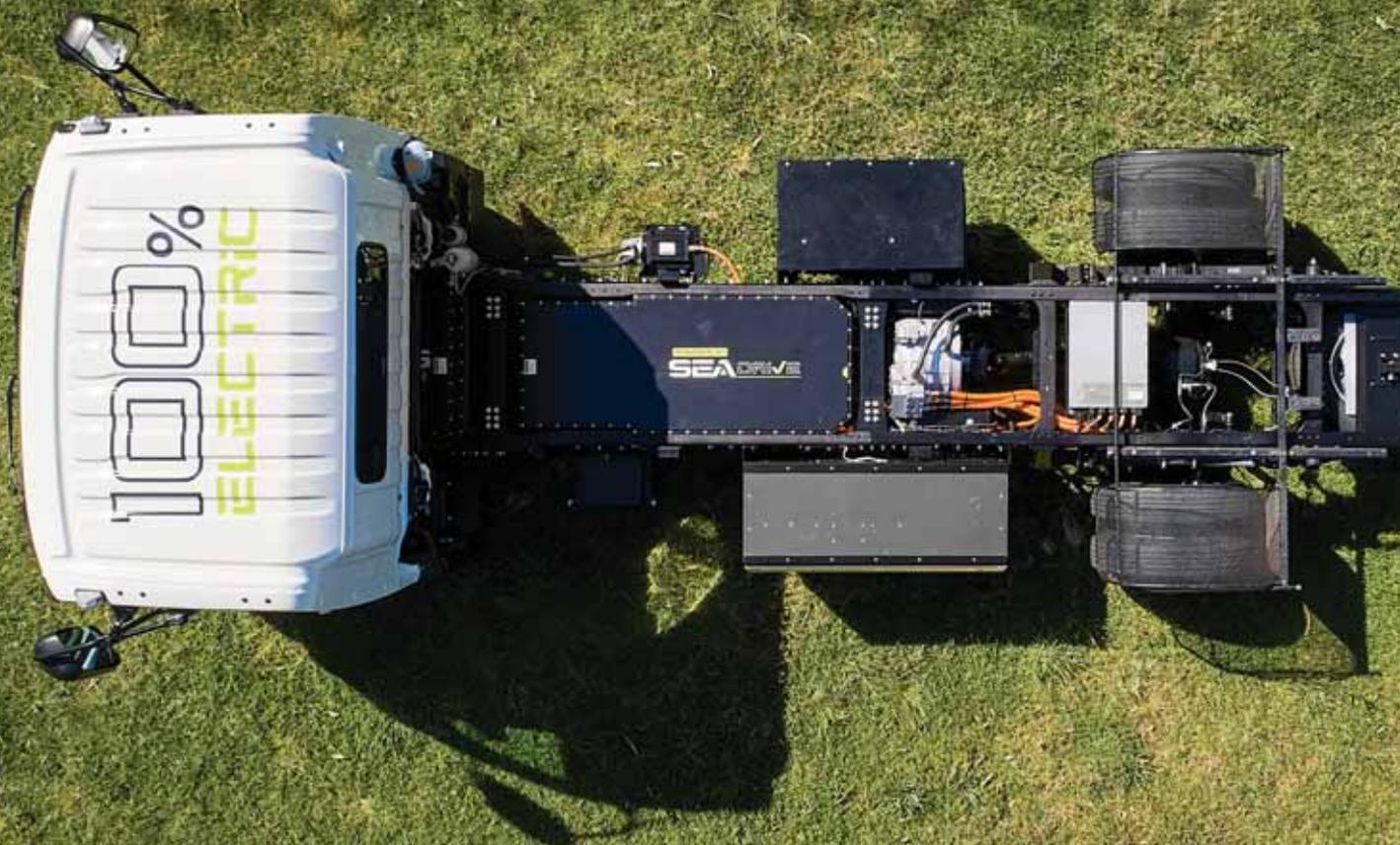
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WORDS BY HARRY WELLER

# HEAVY DUTY, LIGHT TOUCH



AT A FACTORY IN OUTER SUBURBAN MELBOURNE, AUSTRALIA'S FIRST ELECTRIC TRUCK MANUFACTURER IS ASSEMBLING A FLEET THAT WILL ENHANCE THE NATION'S CARBON ABATEMENT EFFORTS.

**AUSTRALIAN START-UP**  
SEA Electric is an electric vehicle manufacturer specialising in the assembly and electrification of commercial vehicles.

The company has grown rapidly since being founded in 2013 and now boasts global reach, with offices in Europe, New Zealand, Thailand and Australia, and its head office in the US.

Despite its success, SEA Electric hasn't forgotten its Australian

roots. During a recent tour of the company's manufacturing facility in the Melbourne suburb of Dandenong, the company's President Asia-Pacific, Bill Gillespie, tells *create* that it is committed to electrifying Australia's transport sector.

Citing the combined forces of rapid developments in the last-mile delivery sector, a growing push by companies to



CLOCKWISE FROM ABOVE: SEA 300-85 EV; the trucks are assembled for each specific order; the motor features high start-up torque; SEA 300-45 trucks arrive in CKD form and are reassembled with electric powertrains.



reduce their emissions, and an improvement in the commercial feasibility of electric vehicles thanks to reductions in battery kWh pricing, Gillespie says corporate Australia is poised to take the plunge and embrace electric trucks.

“Transport makes up around 19 per cent of Australia’s total CO<sub>2</sub> emissions, while the road freight sector in turn accounts for 38 per cent of total transport emissions. Clearly, reducing emissions here can have a major impact

## “IN 2021, THE MEDIUM AND LIGHT TRUCK MARKET IN AUSTRALIA ACCOUNTED FOR HALF OF ALL COMMERCIAL VEHICLES SOLD. JUST UNDER 100 OF THESE WERE ELECTRIC.”

on reducing Australia’s carbon footprint,” he says.

“However, in 2021 the medium and light truck market in Australia accounted for 21,774 vehicles, or half of all commercial vehicles sold. Just under 100 of these were electric, so for Australia to meet a goal of net-zero by 2050 will need a monumental shift.”

That shift is well underway at SEA Electric, which has been working towards the goal of establishing a viable Australian electric truck manufacturing industry since 2013.

The company launched its commercial operations in 2017 and has manufactured about 200 electric trucks and other vehicles both here and overseas.

### ROLL OUT

In September 2021, SEA Electric celebrated a significant milestone when its first electric-powered SEA 300-45 truck rolled off its Melbourne production line, following the company

receiving Australian Design Rules certification for local volume production.

The certification makes it one of only three original equipment manufacturers building trucks in Australia and the only one making an electric truck. The company’s only direct competitor is Fuso, which sells a single 6.5 t eCanter model with a range of 90 km, whereas SEA Electric offers various models from 4.5 t to 22.5 t, with different battery and motor combinations up to a maximum range of 300 km.

The Japanese-sourced Hino trucks, on which the SEA 300-45 and others in the range are based, arrive at the Melbourne facility

as fully constructed and trimmed cabs, and the remainder of the truck is built up from components assembled on site.

Batteries are also assembled on site for each specific order, with trucks rolling through a five-stage process before completion.

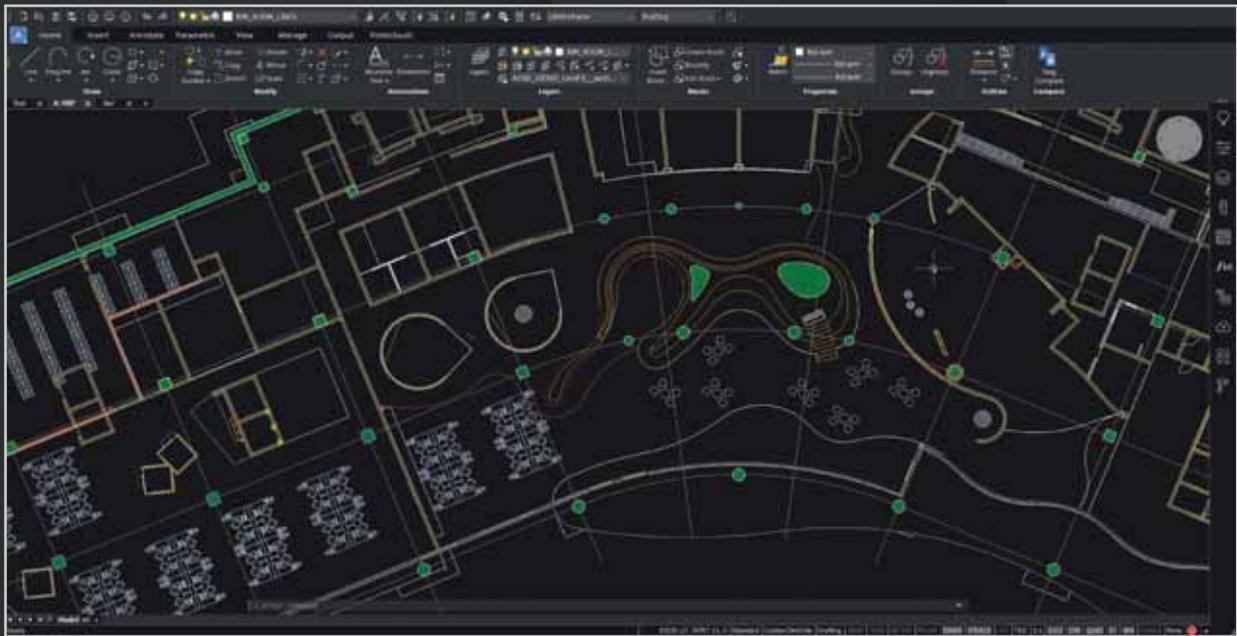
Mewan Jayatilake, SEA Electric’s National Parts and Technical Services Manager, is one of a team of 17 engineers who are engaged on the project, working in the fields of electrical, mechanical and mechatronics.

Jayatilake says SEA Electric’s proprietary motor control technology, the chemistry of its batteries and the location of its components are key areas where the company is ahead of its competitors.

“We’re at the leading edge of technology right now because electric trucks are not necessarily very well-known in the market. ▶

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“We are the first to have wheels turning and actual customers out in the field with our electric trucks,” he says.

“Our technology is slightly different to what is seen or heard of elsewhere. Our batteries are of a different chemistry.

“Our motors are not the standard induction motors that you would find on any other EV conversion. All the transitioning ancillary components that were otherwise belt driven are now driven through electricity.

“A motor or a pump is also powered by electricity rather than by a belt-driven system. All of this means that the trucks we build versus the trucks everyone is familiar with – from a technological perspective and an engineering perspective, there’s very little overlap.”

Jayatilake says the vehicles also use direct drive configuration.

“We don’t have a two-speed differential or a gearbox of any sort,” he says.

“The motor is what handles everything from zero kilometres per hour all the way up to 80 or 110, whatever the limit chosen for the platform is. It’s all one seamless delivery.”

That means the motors need to have both high start-up torque and high running torque, but not a very high number of revolutions per minute (RPM).

“For example, a Tesla electric motor might rev to around 18,000 or 20,000 RPM, whereas our motors tap out at 4000 RPM, but we have about four times more torque right from the start,” Jayatilake says.

“Because our motors produce much higher torque at low revs, the batteries therefore need to discharge their energy at a slower rate. What you get from that is long-lasting components.”

### THE RIGHT FORMULA

Battery chemistry is a key area where SEA Electric diverges from the electric heavy-vehicle herd, ►



**“THE TRUCKS WE BUILD VERSUS THE TRUCKS EVERYONE IS FAMILIAR WITH – FROM A TECHNOLOGICAL PERSPECTIVE AND AN ENGINEERING PERSPECTIVE, THERE’S VERY LITTLE OVERLAP.”**

### LIKE DIESEL

SEA Electric’s Vice President of Asia Pacific, Glen Walker, says the key technical advantage of the company’s proprietary electric power system is that it’s been designed from the outset to suit a commercial vehicle application.

Walker compares the performance characteristics of SEA Electric’s battery and engine combinations to that of a traditional diesel powertrain.

“I liken it to the diesel equivalent of an EV [electric vehicle],” says Walker.

“In the same way that an internal combustion engine has both petrol and diesel variants – the petrol makes the vehicle perform in a certain way and the diesel makes the vehicle perform in a certain

way – so too with electric power systems,” he says.

“You can have low-torque, high-speed motors with batteries that discharge at very high rates, that deliver scintillating vehicle performance, or you can have EV systems that deliver their energy more slowly in a less stressed manner, through lower revving, very high torque motors – in other words, a power system that closely mimics the diesel.

“Whereas a Tesla system, for example, closely mimics a petrol motor car. We set about designing a system for a truck that performs in a similar way to the low revving high-torque diesel internal combustion engine.”

ABOVE: Glen Walker.

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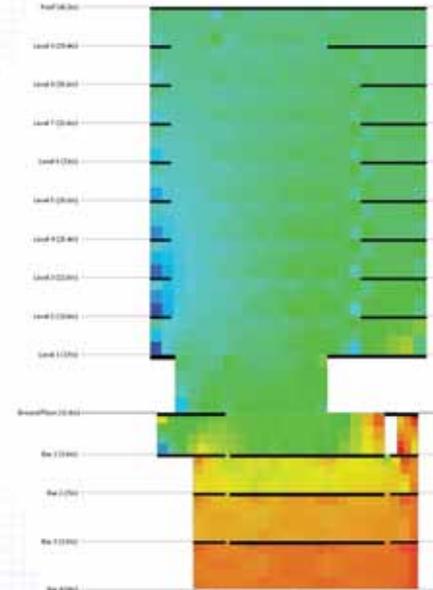
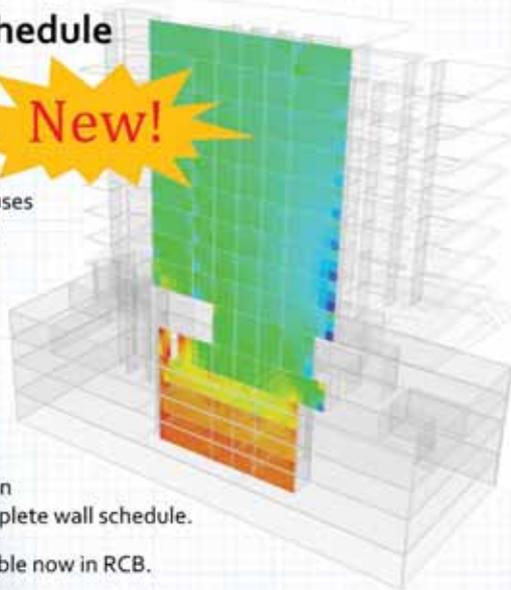
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with the company using a lithium-ion nickel manganese cobalt chemistry that it says provides an excellent balance of energy storage, longevity, performance and safety.

“Our battery chemistry is an NMC [nickel manganese cobalt] type, so our batteries don’t need water cooling or any kind of active cooling,” Jayatilake says.

“They don’t run hot in general, but the thermal management itself is managed by having very slow energy discharges that inherently generate less heat.”



LEFT: Mewan Jayatilake.

## DISCIPLINE DIVERSITY

SEA Electric's Vice President of Asia Pacific, Glen Walker, a mechanical engineer, says the company provides great opportunities for engineers to work across a range of disciplines.

“SEA Electric caters for all manner of engineers, and we do genuine, real, innovative engineering work that is world leading. We have engineers who delve into battery chemistry, battery management systems, battery temperature and securities, and so on,” he says.

“We have engineers who deal with the physics of the motor and how it makes the vehicle perform. We have engineers who deal in the software that controls all the various components and how they relate to each other. And we have engineers who deal in the mechanical structures, in the electrical structures — be it a bent bracket with a hole in it, or a harness.

“We are a company that can provide young, talented engineers with an unbelievable start in our industry. They’ve got the ability to have up close and personal professional experience in all operating areas of an electric vehicle.”



**“BECAUSE OUR MOTORS PRODUCE MUCH HIGHER TORQUE AT LOW REVS, THE BATTERIES NEED TO DISCHARGE THEIR ENERGY AT A SLOWER RATE. WHAT YOU GET FROM THAT IS LONG-LASTING COMPONENTS.”**

He explains that the location of the batteries is another point of difference, with the batteries and power system positioned away from the steer axle, allowing for improved weight distribution and better driving dynamics.

“If you look at any of the competitor electric trucks, you’ll find that the batteries are hung off

the side of the main chassis rails,” Jayatilake says.

“Whereas on our truck the motor, the batteries, the power distribution, everything is on the centre line of the truck. That provides a lot of stability during cornering. It’s all balanced and the truck is comfortable when the mass of the truck is on the centre line.

ABOVE: The battery is positioned for improved weight distribution.

“In the event of an accident or collision where there’s a side impact, the battery is also very well protected by not only the chassis rails but other ancillary components that are often attached to the chassis rail on the side.”

SEA Electric’s current production rate of one truck per week is set to ramp up to six units per week by the end of 2022, with the longer-term goal of 2500 units per annum by 2025.

The company is currently looking to scale up Melbourne manufacturing capability and is eyeing another building that will double its current footprint. ●



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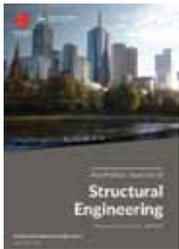
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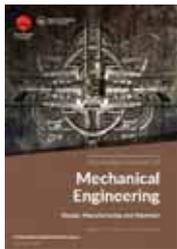
HIGHLIGHTS FROM AUSTRALIA'S MOST UP-TO-DATE ENGINEERING RESEARCH



### TERNARY COMBINED INDUSTRIAL WASTES FOR NON-FIRED BRICK

**Journal:** *Australian Journal of Structural Engineering*  
**Authors:** G.M.S. Islam, A.A. Shubbar, S. Sarker & M. Sadique

This research aimed to explore a depolymerisation technique with ternary combined industrial waste and by-products as binders, including high-volume ladle furnace slag, fly ash and ground granulated blast furnace slag. This is used to produce non-fired and clay-free brick alternatives.



### EFFECT OF COATING MATERIAL PROPERTIES ON THE LUBRICATION PERFORMANCE OF ROLLING CONTACTS UNDER TEHL REGIME

**Journal:** *Australian Journal of Mechanical Engineering*  
**Authors:** A.V. Borgaonkar & I. Syed

This study investigated the effects of the mechanical and thermo-physical properties of coating material on the lubrication performance of rolling contact operating under a thermal elasto-hydrodynamic lubrication, or TEHL, regime. The mechanical and thermo-physical properties considered in the analysis are elastic modulus, density, thermal conductivity and specific heat. The effect of coating thickness was also studied.



### APPLYING CYNEFIN FRAMEWORK TO EXPLORE THE EXPERIENCES OF ENGINEERING EDUCATORS UNDERTAKING "EMERGENCY REMOTE TEACHING" DURING THE COVID-19 PANDEMIC

**Journal:** *Australasian Journal of Engineering Education*  
**Authors:** S. Caldera, C. Desha & L. Dawes

In 2020, "emergency remote teaching" emerged as an accelerated intervention to enable the rapid implementation of online coursework delivery during the COVID-19 crisis. This paper is an exploratory study of engineering educator experiences with online curriculum delivery during that time.

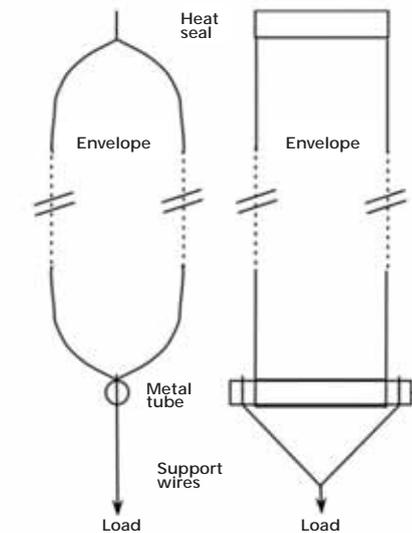


## Tubular polythene film balloons for load lifting in the construction, mining and recreation industries

**Journal:** *Australian Journal of Multi-Disciplinary Engineering*  
**Author:** I. Edmonds

This paper assesses the use of gas-filled tubular balloons for lifting loads in the range 0.1 to 100 t. The advantage of this approach is the lower cost of tubular envelopes relative to spherical envelopes in recreational ballooning and lower lifting costs relative to conventional lifting methods in construction and deep open-cut mining. The physics of lifting with tubular balloons is derived and a method for sealing the tube ends and attaching loads is described.

**RIGHT: A TUBULAR BALLOON ENVELOPE IS SEALED AT THE UPPER END BY WELDING AND AT THE LOWER END BY ADHERING THE LOWER END OF THE FILM TO A METAL TUBE AND THEN ROLLING THE FILM SEVERAL TIMES AROUND THE METAL TUBE BEFORE LOCKING THE ROLL BY ATTACHING THE METAL TUBE VIA WIRES TO THE LOAD.**



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<p><b>09-10</b> NOV 2022 AUSTRALASIAN STRUCTURAL ENGINEERING CONFERENCE (ASEC)</p>	 <p><b>Location:</b> Hybrid and in-person <i>Melbourne</i> <b>Website:</b> <a href="http://aseconference.org.au">aseconference.org.au</a> With its theme "Engineering resilience", ASEC covers topics relevant to structural engineers, students, academics, researchers and industry specialist providers. <b>Save with early-bird registration</b></p>
<p><b>30-02</b> NOV-DEC 2022 HYDROLOGY AND WATER RESOURCES SYMPOSIUM (HWRS)</p>	<p><b>Location:</b> in-person <i>Brisbane</i> <b>Website:</b> <a href="http://hwrs.com.au">hwrs.com.au</a> Join us as we look back at the work and impact of our industry predecessors, discuss current water-related issues and trends and explore the innovations and technologies that are shaping the future of water engineering. <b>Save with early-bird registration</b></p>
<p><b>04-09</b> DEC 2022 INTERNATIONAL CONFERENCE ON COASTAL ENGINEERING (ICCE)</p>	 <p><b>Location:</b> in-person <i>Sydney</i> <b>Website:</b> <a href="http://icce2022.com">icce2022.com</a> ICCE promotes academic and technical exchange on coastal-related studies covering a wide range of topics including coastal waves, nearshore currents, coastal structures, natural hazards and coastal management. <b>Save with early-bird registration</b></p>
<p><b>27-01</b> FEB-MAR 2023 AUSTRALIAN INTERNATIONAL AEROSPACE CONGRESS (AIAC20)</p>	<p><b>Location:</b> in-person <i>Melbourne</i> <b>Website:</b> <a href="http://aiac.com.au">aiac.com.au</a> AIAC is the preeminent aerospace forum in the region, held in conjunction with the Australian International Airshow at Avalon. <b>Early-bird registration opens 12 August</b></p>

**Systems Engineering Test and Evaluation (SETE) Conference 2022**

**12-14**  
SEPTEMBER  
2022

**Location:** in-person *Canberra*  
**Website:** [engaus.org/SETE2022](http://engaus.org/SETE2022)

The global pandemic has been a catalyst for disruption and change across many interconnected socio-technical systems. Expertise in the domains of systems engineering and test and evaluation is uniquely placed to have a far-reaching impact on enabling and realising resilient systems across domains.

The SETE 2022 Conference will explore the theme 'enabling resilience through disruption' in a forum that allows participants to extend networks and learn from leading practitioners and academics.

**Register at**  
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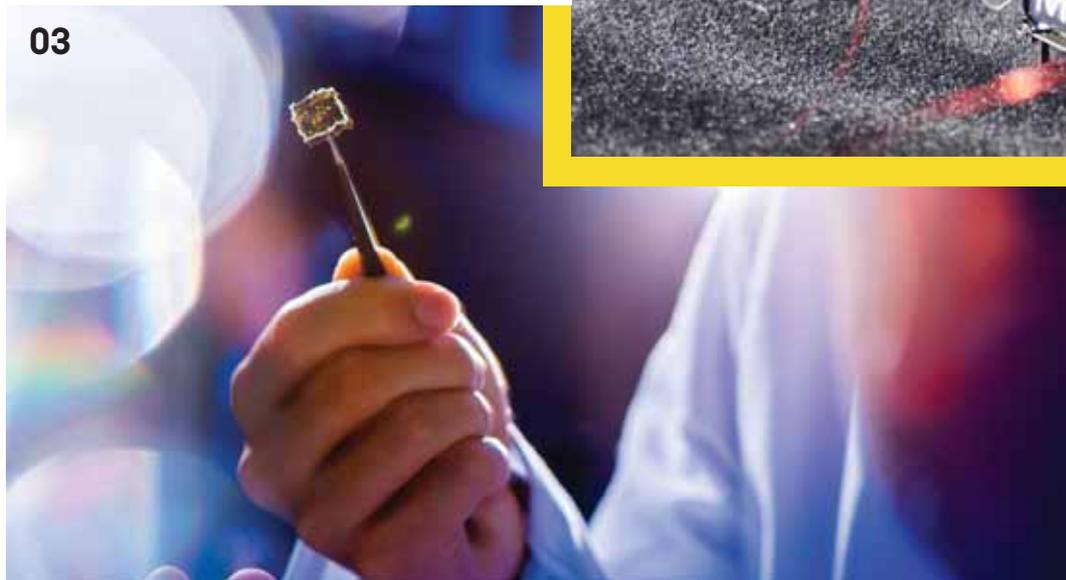
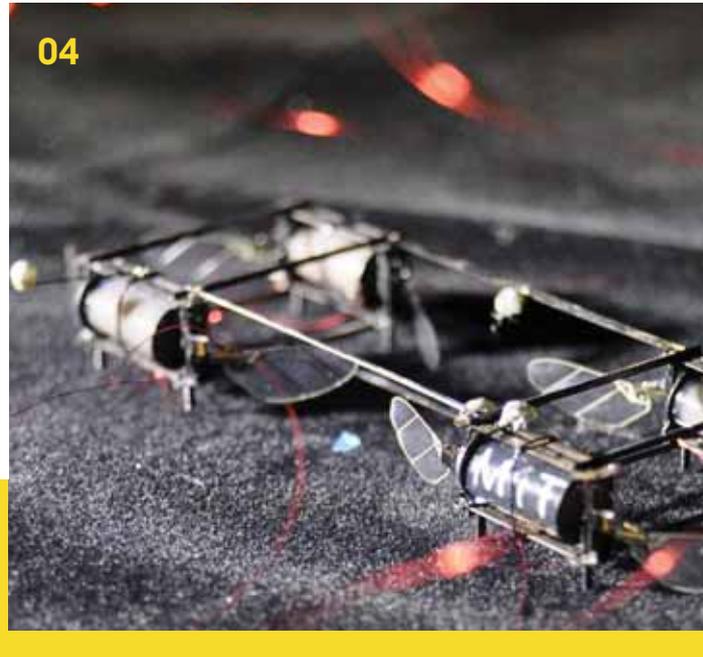
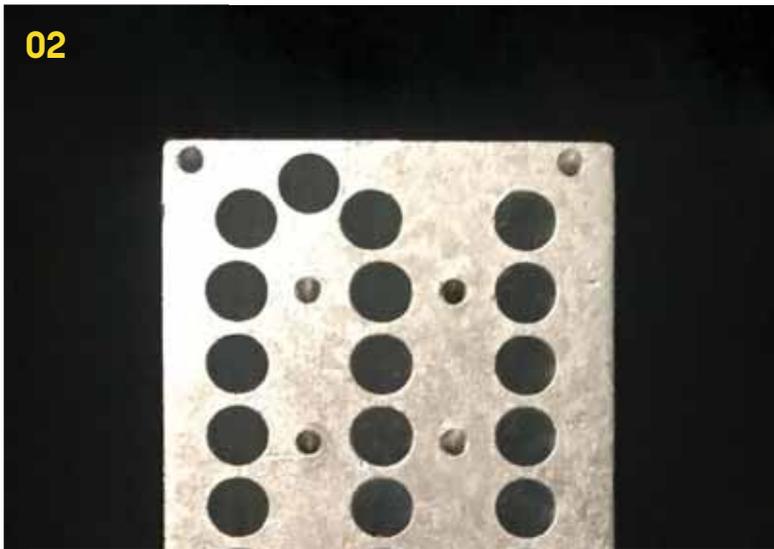
**CLIMATE SMART ENGINEERING CONFERENCE 2022 (CSE22)**

**CSE22 Registrations open**

Engineers Australia is proud to announce our Climate Smart Engineering Conference 2022, held on 22-23 November. CSE22 will be a solution-focused, two half-day event profiling national and international working and relevant projects.

**Registrations now open:** [eacse.com.au](http://eacse.com.au)

THE LATEST DEVELOPMENTS FROM AROUND THE WORLD.



## 01 Clot detector

*This biomedical microdevice detects platelet changes in a blood sample. Image: The University of Sydney*

A microdevice being developed at the University of Sydney has the potential to sense blood clots, giving advanced warning of heart attack or stroke. Biomedical engineer Dr Arnold Lining Ju's technology detects changes in platelets in a blood sample, pinpointing the presence of clotting and white cell inflammation responses. "How this device would work is that an at-risk person – for example, someone with heart disease – would use it daily," Ju says. "Using a finger prick test, the device would monitor their blood and alert them to any potentially dangerous changes. If a change was detected, they would need to present for more monitoring at a hospital." Ju's team hopes to enhance the device by using computational fluid dynamics simulations to better understand the mechanical forces in a blood sample and drawing on artificial intelligence to create personalised blood profiles of a patient.



## 02

### Quantum flute

*The holes in this "quantum flute" create different wavelengths that can be used to encode information. Image: Schuster Lab*

University of Chicago researchers have developed a way to control photons that could lead to advances in quantum computing. Described as a "quantum flute", the technology uses a long cavity in a block of metal that has had offset holes drilled into it. "The photons don't interact at all, but when the total energy in the system reaches a tipping point, all of a sudden, they're all talking to each other," says Associate Professor David Schuster. "You can send one or several wavelengths of photons across the whole thing, and each wavelength creates a 'note' that can be used to encode quantum information." A qubit can then control those 'notes', creating relationships between photons that would usually only interact on a one-to-one basis. "If you wanted to build a quantum computer with 1000 bits and you could control all of them through a single bit, that would be incredibly valuable," Schuster says.

## 03

### Magnetic battery monitor

*A sample of the magneto-ionic material that can be used to monitor battery life. Image: Douglas Levere/University at Buffalo*

A new system developed by University at Buffalo engineer Shenqiang Ren uses magneto-ionic material to monitor the power left in rechargeable batteries. Designed for use with lithium-ion batteries, the technology uses a combination of vanadium, chromium and cyanide with an aqua ligand – a compound that decreases in magnetism as lithium ions enter or leave it. Tracking changes in the magnetism provides an indicator of how much charge remains in the battery. "The main goal of this project was working on the magneto-ionics, which uses ions to control the magnetism of materials," says Ren. "As the lithium ions travel in or out of the material we are using, the material will change its magnetisation. We can monitor the magnetism, and this enables us to indirectly monitor the lithium ions – the state of charge."

## 04 Firefly robot

*Inspired by fireflies, these tiny robots emit light in different colours and patterns. Image: Massachusetts Institute of Technology*

Engineers at the US's Massachusetts Institute of Technology (MIT) have drawn inspiration from fireflies to create insect-sized robots that emit coloured light as they fly. These robots are too small to carry sensors,

but emitting light, created with electroluminescent zinc sulphate particles in the soft actuators that control their wings, allows them to be tracked as they carry out tasks. "If you think of large-scale robots, they can communicate using a lot of different tools – Bluetooth, wireless, all those sorts of things," says MIT Assistant Professor Kevin Chen. "But for a tiny, power-constrained robot, we

are forced to think about new modes of communication. This is a major step toward flying these robots in outdoor environments where we don't have a well-tuned, state-of-the-art motion tracking system." The electroluminescent particles do not affect the flight capability of the robot, increasing its weight by just 2.5 per cent.

## Jo Fisher

CPEng, Director

Howarth Fisher and Associates

JO FISHER'S GEOGRAPHY STUDIES — AND HER CAREER — TOOK A DIFFERENT TURN WHEN SHE WAS INTRODUCED TO ENGINEERING.

JO FISHER had not intended to be an engineer. She was studying geography in the UK, when she was offered a scholarship to study traffic engineering as a master's degree.

"The university specifically wanted geographers as well as civil engineers to undertake the course," she tells *create*.

"You think more laterally if you've come from a different discipline."

Today, Fisher jointly runs Howarth Fisher and Associates, the Hobart engineering consultancy that she co-founded in 2006. She believes her geography background still informs her engineering work, however.

"The transport planning perspective of integrating land use and traffic in its entirety is relevant," she reflects. "Looking at complex development sites and trying to achieve design which maximises and makes most efficient use of land space and road and intersection designs is critical to their success."

Her business today covers civil, structural and transport engineering and encompasses everything from traffic impact assessments to assessing road network safety and integrating transport linkages

"One of the projects we're working on at the moment is Wilkinsons Point, which is an area of land which is being developed in the north of Hobart for mainly sports-based land uses," she says.

## 03

### TIPS FOR SUCCESS

**1** There is value in specialising in one area rather than seeking to become a generalist.

**2** Develop the ability to work in big project teams.

**3** You can benefit from concentrating on doing one aspect of engineering really well; it gives you a point of difference.



"It's located on a site which is very difficult to get in and out of from the arterial road network — it's basically saturated in the peak periods.

"[We're] modelling and coming up with solutions to get not only vehicular flows but also ferries and other sustainable transport modes to the site in an integrated development master plan. We are then designing the road network to cater for buses, pedestrians, cyclists, as well as achieving sufficient parking to meet the demand."

Fisher describes the work as innovative and challenging, adding that running a small business has extended her capabilities.

Something that has helped in that regard is having been accredited as a Chartered engineer.

"For people to know that you have met the criteria for Chartered status is important, and for your clients to know that is important," Fisher says.

Another incentive, she points out, is the increasingly common requirement for projects to be signed off by engineers with Chartered credentials.

"Our firm believes strongly in the value of this Chartered status and guarantees our autonomy and integrity with project delivery," Fisher says. ●

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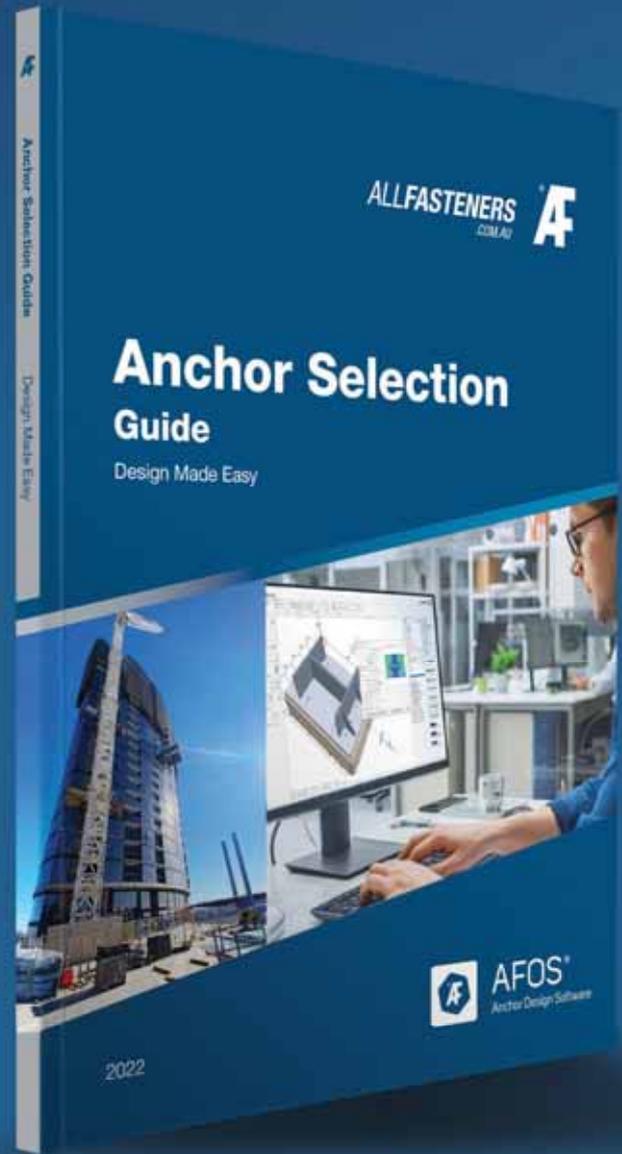
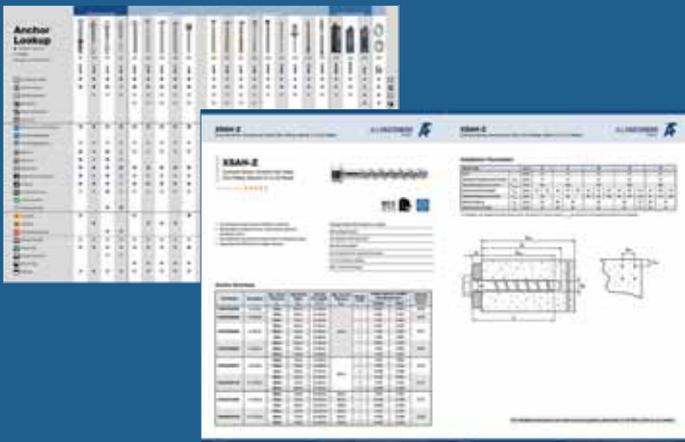
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# Design Made Easy

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