

VOL. 9 | NO. 5 | JUNE 2023

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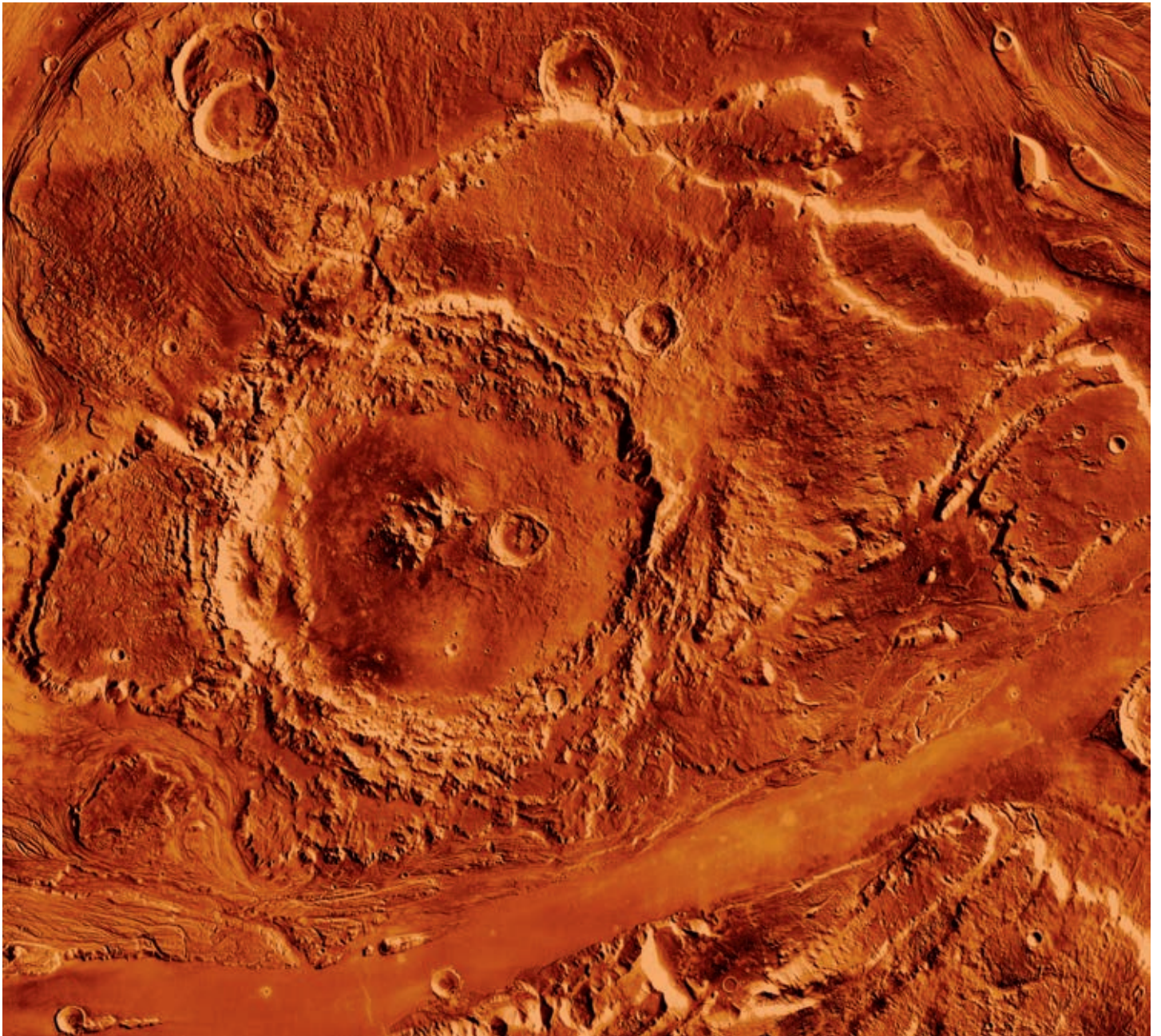
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# CONTENTS

003

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VOL. 9 | NO. 5 | JUNE 2023



## GENERATIVE AI

Advances in neural networks are set to change the way engineers approach their work. What will the profession look like in the future?



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AUSTRALIA

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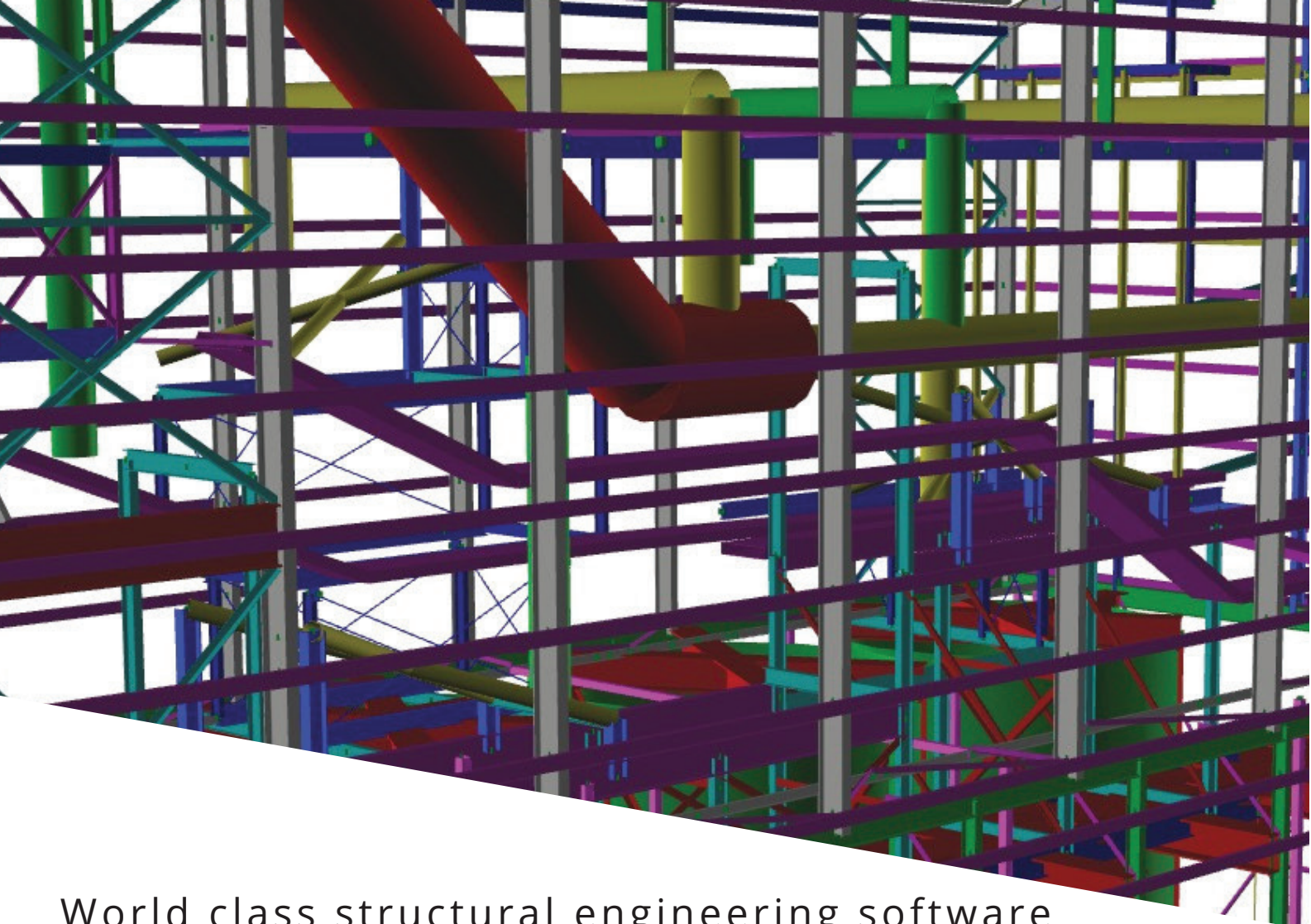
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**14** **EDUCATION**  
To meet its AUKUS goals, Australia will need nuclear-trained engineers.

**32** **ENERGY**  
Ensuring electric batteries are safe as well as carbon-reducing.



**38** **DEFENCE**  
The renewed interest in balloons for civil as well as defence applications.

**46** **ENVIRONMENT**  
Wetland rehabilitation could be a big source of carbon sequestration and storage.



**EVERY ISSUE**

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

**53** ENGINEERING TRENDS

**55** EVENTS

**56** TECH WATCH

**58** KEYSTONE

**NEWS**

**08** **AWARD WINNERS**  
A Melbourne freeway upgrade is recognised as Australia's best construction project of the year.



**11** **MENTORSHIP**  
Both sides of the mentor relationship have benefited this civil engineer.

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





## Mind in the machine

ARTIFICIAL INTELLIGENCE IS A SUBJECT OF KEEN DEBATE — AND ONE WITH TRANSFORMATIVE POTENTIAL FOR ENGINEERING.

**WELCOME TO** the latest edition of *create*. June is when we celebrate International Women in Engineering Day, a time when the world marks the achievements and contributions of women to the profession.

We will continue to work hard to meet our goals as members of the Champions of Change Coalition for equal representation of women in engineering, which currently stands at just 14 per cent in Australia.

This statistic means engineering needs to do more to ensure it is representative of the community it serves and give itself the benefit of unlocking the latent talent of half the population.

This article explores this game-changing tool and its capacity to generate design options and solutions to engineering challenges.

It can simplify and condense the design and test phases of projects and reduce overheads in ways that could take engineering forward at warp speed.

AI is also a potent development unfolding in real time — and that presents unique workplace and societal challenges.

We are at a frontier with AI where, as is often the case with technological advances, legislation is lagging and ethical debate is raging.

ChatGPT is a big one, with implications that stretch the ethical gamut from cheating in academia and amplifying biases to disrupting the very nature of human interaction.

The promise of AI in streams of bio-medical engineering and clean energy generation is significant, so to the modelling and predictive capabilities that would enable communities to better prepare for the extreme outcomes of climate change.

We also take a look at the AUKUS submarine project, which promises a wealth of opportunity in streams of engineering as well as presenting some challenges in the talent pipeline when the profession is already experiencing a skills shortage.

Watch this space for new initiatives to encourage more students into STEM and more women into engineering.

**“As engineers, we can be our own champions and help students, their parents and career advisors understand the many exciting opportunities the profession presents.”**

Our research shows a significant barrier to young women considering studying engineering is a lack of awareness of what an engineer does. As engineers, we can be our own champions and help students, their parents and career advisors understand the many exciting opportunities and impacts the profession presents in all its forms so they might see themselves pursuing a career in the field.

Our cover story explores the potential — and potential pitfalls — of generative artificial intelligence. The AI debate is a complex one.

It has captured the imagination in a way few other technological advances have. Whether the interest is rooted in concern over sci-fi depictions of malicious, self-aware robots or optimism for a brave new world of streamlined design, efficient use of resources and a fast track to precision solutions, the fascination is real.

Engineers and scientists have been working around the edges of AI for decades, seeing the vast potential in adaptive programs that “learn” and can operate autonomously.

The step forward into generative AI with commercial offerings like



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AN UPGRADE TO ONE OF THE COUNTRY'S BUSIEST FREEWAYS THAT BOOSTED SAFETY AND REDUCED TRAVEL TIMES HAS BEEN RECOGNISED WITH THE MOST PRESTIGIOUS PRIZE IN THE AUSTRALIAN CONSTRUCTION INDUSTRY.

**A PROJECT** revamping a section of Melbourne's M80 Ring Road was announced as the winner of the 2023 Australian Construction Achievement Award at a gala dinner at the Crown Palladium in Melbourne last month.

Widening 5.7 km of freeway between Sydney Road and Edgars Road in Melbourne's north, the project was delivered by CPB Contractors and Major Road Projects Victoria.

"This complex project reduced traffic congestion by improving safety and increasing capacity through additional lanes, ramps and a smart freeway management system, all constructed in and around live traffic," said CPB Contractors Project Director Raphael Touzel.

"The keys to the project's success were collaboration, unique technical solutions, creating a social legacy

and an innovation and sustainability culture."

Working alongside 165,000 vehicles each day, the team completed its work six months ahead of schedule and under the client's budget. The M80 upgrade also made significant environmental achievements, marking the first time an Australian freeway used recycled content in every pavement layer.

The Australian Construction Achievement Award is presented

**"THE KEYS TO THE PROJECT'S SUCCESS WERE COLLABORATION, UNIQUE TECHNICAL SOLUTIONS, CREATING A SOCIAL LEGACY AND AN INNOVATION AND SUSTAINABILITY CULTURE."**

LEFT: An expanded footbridge formed a key component of the M80 upgrade. BELOW: The winning team.

annually by Engineers Australia and the Australian Constructors Association.

Engineers Australia CEO Romilly Madew AO praised the seven finalists for continuing to strive for excellence.

"In trying times, constructors have relied on strong and positive workplace cultures and uncompromising standards of safety and quality," she said.

"They have embraced technological advances in planning, design and project management to earn their place among the stable of finalists." ●

**JONATHAN BRADLEY**







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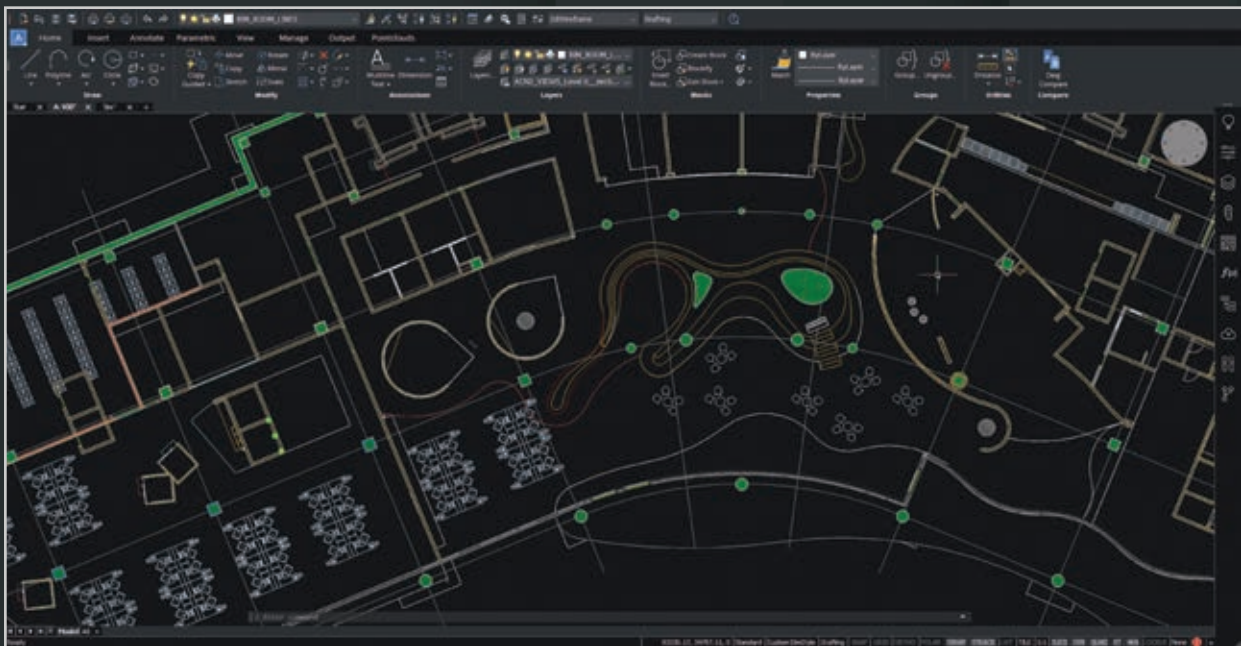
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# Building talent

FOR INTERNATIONAL WOMEN IN ENGINEERING DAY, 23 JUNE, *CREATE* LOOKS AT THE BENEFITS A GOOD MENTOR CAN HAVE FOR A STEM CAREER.

PICTURED:  
Brittany  
Harris, Aurecon.

WHEN BRITTANY Harris took her first engineering job, she was the only woman on site.

Working in a construction role, Harris described the gender balance as a big challenge.

"It was a bit confronting," the civil engineer told *create*.

"Diversity was a big thing for me in construction."

The experience taught her such things as the importance of aligning her career with her values; Harris said that, since then, she has looked to work with companies that value diversity and equal opportunity.

She has also found strength in mentorship relationships – first as a mentee and now as a mentor.

"I've always had really good mentors, male and female," Harris said. "I think it's important to have those connections in the industry to expand the opportunities available to you and for guidance throughout your career."

Harris has appreciated the value of mentorship since her undergraduate years, seeking out the guidance of people who were already working in the field.

"I first sought out mentors through Young Engineers Australia Queensland," she said.

"Seeking out mentors has been such a game changer for me to expand my mindset – and my skillset as well – and to help guide me throughout my career. It's been so beneficial to reach out to different types of mentors

for different types of things when I do need that guidance in my career."

She appreciated the connections she found through Engineers Australia because they provided her access to industry figures: it appealed to her sense of practicality.

"I find that I've needed different mentors throughout different stages of my career because I've always been the type of person who just asks and goes after what I want," she said.

"Usually when I start to look for a change in my role, or when I've hit a roadblock in my career, or when I've got bored and I'm looking to do something different, I've sought out that advice and guidance from mentors."

When seeking out mentors, the most important thing Harris hopes for is a "natural connection".

"When my authentic qualities come out and where they're easily approachable, and I feel comfortable to ask questions and just be myself," she said.

"It's more about the connection and the type of skills or, when I'm faced with problems, how to navigate that in my career."

Now a Senior Consultant at Aurecon, Harris has also become deeply engaged in the other side of the mentor-mentee relationship, including having held volunteer positions with Young Engineers Australia Queensland and Dream Big ▶

**"I THINK IT'S IMPORTANT TO HAVE THOSE CONNECTIONS IN THE INDUSTRY TO EXPAND THE OPPORTUNITIES AVAILABLE TO YOU AND FOR GUIDANCE THROUGHOUT YOUR CAREER."**

Australia, a group that works towards gender equality in science, technology, engineering, arts and mathematics.

She sees storytelling as a great way to help develop the mentorship relationship.

“Once I started connecting to other people’s stories and what they have experienced throughout their career, I was so much more open to all the opportunities available in a STEM career or different pathways you could go,” she explained.

“I always loved project management and conceptualising bigger ideas and travelling globally, and I loved networking with other people.

“So once I expanded my mindset through other people’s storytelling of their careers, I was much more inspired to know that there was other opportunities

**RIGHT and BELOW:** Harris, now a Senior Consultant, at work on-site.



**“I’VE ALWAYS GIVEN PEOPLE THE TIME TO HAVE THAT ONE-ON-ONE CHAT, TO CONNECT WITH THEM AND GET TO KNOW THEM AND WHAT THEY’RE SEEKING IN THEIR CAREER.”**

and pathways available for me and I wasn’t restrained to one specific niche.”

Harris believes her role is to show up for her mentees now the way her mentors have been there for her.

“I’ve always given people the time of day to have that one-on-one chat, that coffee chat, to connect with them and get to know them and what they’re seeking in their career,” she said.

“When they’re going through a transition or wanting a bit of a

change, they’ll ask me for advice or, when they’re experiencing a block with their manager or wanting to do something different, I’ll help them through that.”

When it comes to the young engineers she works with, Harris sees herself as their “biggest cheerleader”; she loves to watch them succeed.

But that’s not all she gets out of her role as a mentor.

“I think I actually get a lot of satisfaction out of it: helping provide the coaching,

mentoring and guidance towards them, just to make them feel at ease and supported,” she said.

And for women who might be confronting the barriers Harris found early in her career?

“I just say, ‘Don’t let it be a limitation for you. And as long as you have your success principles, ask for what you want and seek out mentors.

“It’s okay to receive help when you need it.” ●

**JONATHAN BRADLEY**

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



SOME OBSERVERS SEE THE AUKUS SUBMARINE PROJECT AS A BOON FOR THE ENGINEERING PROFESSION. OTHERS WONDER WHERE EXACTLY ALL OF THE NECESSARY TALENT WILL COME FROM.

WORDS BY CHRIS SHEEDY

PICTURED:  
The USS Asheville, a US nuclear-powered submarine off the coast of Perth.

**W**HEN VICE Admiral Jonathan Mead visits the Osborne Naval Shipyard, which will be the birthplace of Australia's eight new nuclear-powered submarines, built as part of the AUKUS security pact between the US, UK and Australia, he finds it "quite therapeutic".

That feeling has little to do with the fact that he's on the picturesque Lefevre Peninsula in South Australia, and more to do with the knowledge that he's standing at the birthplace of a thrilling, new adventure in Australian industry.

"I go down there and stand on the Port River," said Mead, who is also Chief of the Nuclear-Powered Submarine Taskforce.

"Within seven years, this will be a shipyard that will have already commenced building our first nuclear-powered submarine. At the heart of the shipyard will be the key engineers, such as nuclear engineers, electrical

engineers, electronics and mechanical engineers.

"We'll also need naval architects, communication specialists, materials engineers, environmental engineers, test evaluation and submarine systems and sensors engineers."

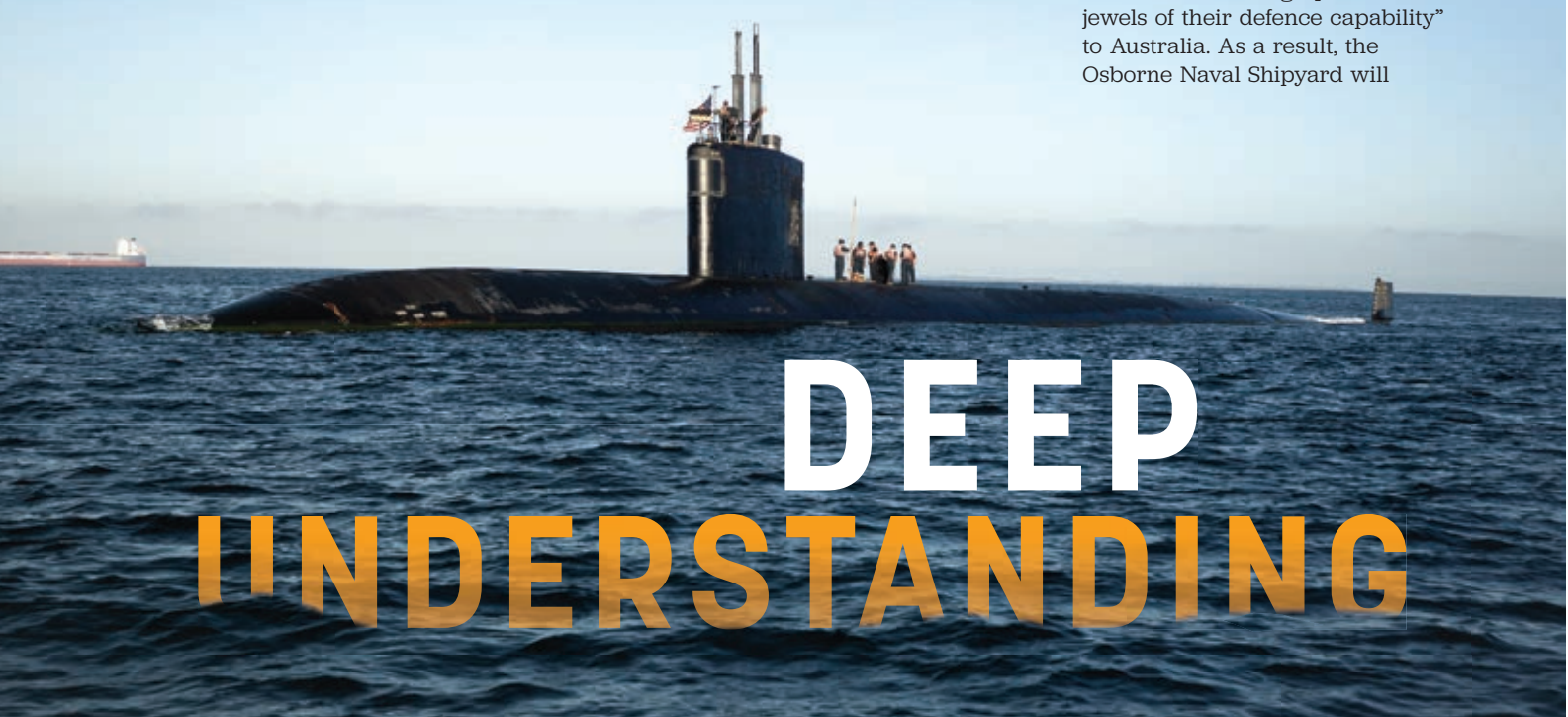
That's just to name a few. There will also be physicists, project managers, welders, plumbers, electricians and more in a workforce that will number some 20,000 over the next 30 years.

The challenge is that it will need to be staffed with bountiful engineering talent at a time when there's a marked drought in the ranks of the profession worldwide. There is also high demand for those already in the profession.

**TECHNOLOGY LEADERSHIP**

The AUKUS pact focuses on modernising and enhancing each military's capabilities - not just in submarines, but also in hypersonic missiles, cyber operations, quantum computing and other areas.

In the deal, Mead said, the US and UK are offering up "the crown jewels of their defence capability" to Australia. As a result, the Osborne Naval Shipyard will



DEEP UNDERSTANDING

quickly become one of the most complex and advanced technology hubs in the world.

“Osborne will be one of four shipyards at which the AUKUS partners build nuclear-powered submarines,” Mead said.

“There are two in the United States, there is one in the United Kingdom, and Osborne will be the fourth. We’re talking about the most advanced and sophisticated technology in the world associated

**BELOW LEFT:**  
Australian Prime Minister Anthony Albanese, US President Joe Biden and UK Prime Minister Rishi Sunak at the AUKUS announcement in March 2023.

“Her friends and her classmates will accordingly be physicists, project managers, welders and architects. Some of them will be regulating the nuclear power program.”

Where will this talent come from?

When announcing the multi-nation security agreement, the federal government outlined a need to fill around 20,000 direct jobs in Australia over the

nuclear workforce, based on a review of staffing and skills that support the United States’ 70 nuclear submarines, both for construction and maintenance, as well as for operations.

He concludes that, to build eight nuclear-powered submarines, the Australia-based workforce will need, at the pyramid’s top, at least 215 nuclear subject matter experts.

“These are people that have to make critical decisions about



with naval nuclear propulsion, and Osborne will be at the heart of it.

“That fact, by its very nature, I assess will trigger second and third-order effects such as stimulation of children to study STEM – teenagers and girls in particular. That’s a real focus for us, looking at primary and secondary students.

“Out there right now, there is a 15-year-old student and hopefully she’s studying STEM. But if she’s not, I hope that what we’re doing now is transforming her thinking and she will one day be the engineer or the commanding officer of one of our nuclear-powered submarines.

## **“WE’RE TALKING ABOUT THE MOST ADVANCED AND SOPHISTICATED TECHNOLOGY IN THE WORLD ASSOCIATED WITH NAVAL NUCLEAR PROPULSION, AND OSBORNE WILL BE AT THE HEART OF IT.”**

**ABOVE RIGHT:**  
USS *Hawaii*, a Virginia class US nuclear-powered submarine makes its way to berth in Western Australia.

next 30 years – of which up to 8500 would be in the industrial workforce – to deliver the AUKUS submarine program.

Dr Edward Obbard, a Senior Lecturer at the University of New South Wales in the School of Mechanical Engineering, and Program Coordinator for the UNSW Master of Engineering Science (Nuclear Engineering) course, has analysed in detail the expertise needed to fill out a

operations and safety,” Obbard said. “You really need to be at the peak of your career to do that. You need to be at the cutting edge of international science to make a decision about the safety of a nuclear reactor or a nuclear submarine.”

That community of people who are at the top of the nuclear materials and nuclear safety ▶



LEFT: Vice Admiral Jonathan Mead (left) with Australian ministers Pat Conroy, Richard Marles and Matt Keogh, and US Rear Admiral Richard Seif aboard the USS Asheville.

## “YOU NEED TO BE AT THE CUTTING EDGE OF INTERNATIONAL SCIENCE TO MAKE A DECISION ABOUT THE SAFETY OF A NUCLEAR REACTOR OR A NUCLEAR SUBMARINE.”

game, with deep knowledge of related aspects such as public engagement, social science and emergency planning, typically need at least 20 years’ experience of working in the field.

“They’ve probably got a research degree,” he said. “Maybe they did a PhD or at least a master’s. These people are in very short supply worldwide.”

In the middle tier of the pyramid are people with a good amount of subject matter expertise on things nuclear.

In that tier, Obbard said, we’ll need at least 1075 specialists in maintenance roles and another 1560 in operational roles.

“These are people with around 10 years’ experience, who are able to do any sort of difficult engineering analysis and science, including research. They could be chartered engineers,” he said.

“Often, these people are midway through their careers, so they might become subject matter experts one day.”

And in the lower tier, the industry will require around



LEFT: Dr Edward Obbard, the University of New South Wales

3000 nuclear-aware tradespeople who have had specialist training around radiation safety, quality control, and more.

Currently, Australia would have trouble staffing even 10 per cent of these roles, Obbard said. Add in the fact that most of the jobs will be based in Adelaide or on a naval base in Western Australia, and the challenge becomes greater.

### UNDERGRADUATE START

The success of the AUKUS program, on which several

### SOCIAL LICENCE

Vice Admiral Jonathan Mead is aware that the AUKUS submarine program, to be a real success, will require social licence. Australians will need to be comfortable with the idea of a program that has the word “nuclear” attached.

“We need to work on social licence with the broader Australian community,” he said.

“We need to be able to explain, for instance, the fact that we have had over 280 visits by nuclear-powered submarines and ships to Australia over the past 60 years, without incident. We need people to understand that we’ve run a research reactor at Lucas Heights and have been doing so for six decades. We need them to know that the sealed reactor in a nuclear submarine will never be opened for the life of the vessel.

And while we do not have great experience in naval nuclear propulsion, we do have an understanding of the science behind it, he said. Australia is working with its AUKUS partners to build the domestic nuclear skills needed so that the country’s first nuclear-powered submarines can become a reality in the early 2030s.

But there’s also a need to bring the public along in the discussion.

“I think we have a responsibility to explain to the Australian community that this endeavour is about the safety of the submarine crew, the safety of the community and the protection of the environment,” Mead said.

important pieces of Australia’s future security capacity are now being based, will rely heavily on our ability to attract, engage and retain university students in nuclear engineering and other nuclear science-based programs.

Obbard’s PhD student Tina Baradaran, who is also president of the Student Nuclear Society at UNSW, is researching nuclear education: how people learn nuclear engineering in Australia.

“Predominantly in Australia, people learn nuclear engineering in the workplace,” she said. “I’m ▶



## 5 reasons to choose Quadshore™ 150 over conventional propping systems

Designed by engineers at Coates and Monash University, Quadshore 150 is the lightest, heavy-duty propping solution in the world. Here's why you should consider hiring it for your next project.

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### 3. Safer due to less manual handling

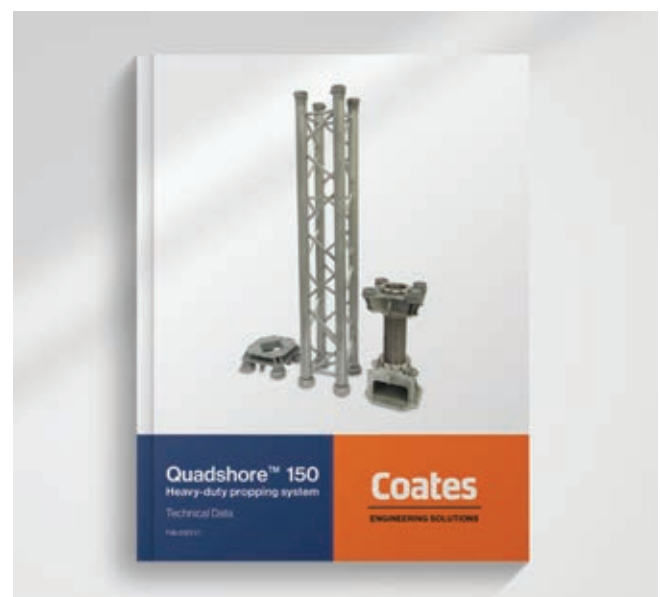
Conventional propping systems pose challenges around safety due to the need for manual handling and heavy machinery or equipment to unload and install it. As Quadshore 150 is considerably lighter with no bolted connections between its modular beams and a smaller site footprint, Coates expects the number of lost time injuries reported by customers will be dramatically reduced.

### 4. Reduced costs for labour, transport and consumables

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

### 5. Lower carbon footprint due to less transport

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



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studying how people learn about it in the workplace, specifically at the Australian Nuclear Science and Technology Organisation. And I'm looking at how to effectively teach or train nuclear engineers in the university environment, to ensure we have enough nuclear engineers for the future."

To achieve AUKUS's goals, the nation would need to start training people from the beginning of their university studies, Baradaran said. To that end, part of her study looks at how current first-year engineering students become engaged with nuclear science subjects.

"This project is about engaging students in their first year to design, build and test an underwater robot," she said. "Within this project, in their first semester at university,

we introduce them to nuclear engineering content.

"We teach them fundamentals of nuclear engineering, what the discipline is about and other important things related to nuclear such as radioactivity, decay, isotopes, types of reactors, etc."



LEFT: Tina Baradaran, the University of New South Wales.

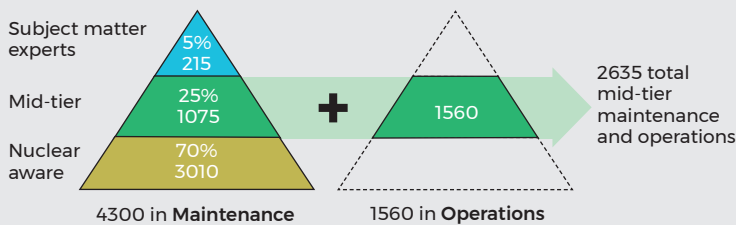
This has attracted students not just because of the practical appeal of building an underwater robot – which relates nicely to the AUKUS program – but also, Baradaran said, because young engineers have a genuine interest in understanding nuclear science.

In fact, Mead said, training programs have already begun.

"The Commonwealth has entered into an agreement with the South Australian government to establish a skills and training academy at the shipyard," he said.

"We have increased Commonwealth-supported places for people to undertake funding-supported university degrees, particularly in STEM subjects. We are working with our partners to embed industry personnel into US and UK shipyards. And we're working closely with universities around Australia on how we can develop pathways for all the relevant disciplines." •

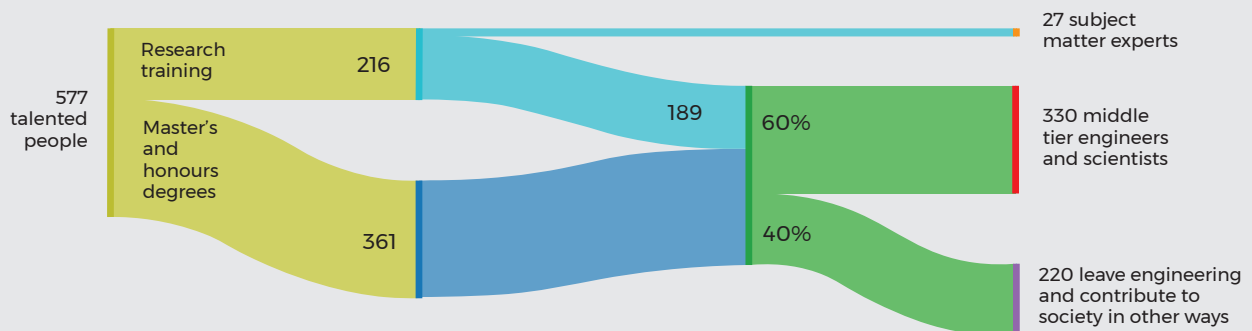
### NUCLEAR KNOW-HOW



Estimated skills pyramid for maintenance and operations of an Australian nuclear submarine program, comprising eight boats, based on the US submarine maintenance workforce for 70 boats of 38,000, plus a crew of 130 for each boat, rotated with 50 per cent onshore, in operational roles.

**"WE TEACH THEM FUNDAMENTALS OF NUCLEAR ENGINEERING, WHAT THE DISCIPLINE IS ABOUT AND OTHER IMPORTANT THINGS SUCH AS RADIOACTIVITY, DECAY, ISOTOPES AND TYPES OF REACTORS."**

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WORDS BY **CHRIS SHEEDY** AND **DAVID BRAUE**

# MIND AT WORK

GENERATIVE AI — INTRODUCED INTO THE CONSUMER SPHERE BY TOOLS SUCH AS CHATGPT — WILL SOON REVOLUTIONISE ENGINEERING IN WAYS WE CANNOT YET IMAGINE.

**T**HE TECHNOLOGY in generative artificial intelligence (AI) products such as ChatGPT has captured imaginations because it represents the creation of intelligence itself.

It has captured the imagination because it is imagination.

Generative AI produces entirely new ideas, images, approaches and angles.

Siqi Chen, CEO of fintech startup Runway, described the advances made possible by generative AI as “orders of magnitude greater than every other technological change we’ve ever had in history”.

And once it begins to make its way into engineering on a commercial scale – as it will very soon, said Dr Kellie Nuttall, AI Lead at Deloitte – it will give engineers the ability to design in an entirely new way and at a previously unimagined pace.

“It won’t be long before engineers can ask generative AI to optimise a design for very specific objectives,” Nuttall, who runs Deloitte’s Strategy and Business Design practice, said.

“Whether that might be for climate outcomes, or they want a building to look a particular

way without compromising the integrity of the structure, they will simply be able to prompt by offering clear objectives.

“The first pass will be done without any human intervention. It won’t be perfect, but it will be impressive, and I think it will provide an amazing starting point for design. What might have taken months – creating and building

five different bridge designs into CAD or a building information system, creating a video flyover, etc. – that will be done in days.”

Nuttall said she has never seen such a level of interest in any technology compared to what she’s seeing today in generative AI.

“Every board and every C-suite is talking about it,” she said.

“Over the length of my career, I’ve never seen this much interest, debate and action at executive tables as I’m seeing right now.”

## WHAT IS GENERATIVE AI?

As such technological developments as machine learning, artificial intelligence, automation and more have been tested, accepted and used within engineering and construction, major efficiencies have been realised.

Generative artificial intelligence is the next natural step – except it’s more like a leap.

If we go straight to the horse’s mouth and ask ChatGPT to explain generative AI, it responds with: “Generative AI refers to a subset of artificial intelligence techniques that involve using machine learning models to generate new content, such as images, music, text and even video.

“Unlike traditional AI models that are designed to recognise and classify existing data, generative models can create entirely new content that has never been seen before,” the algorithm continued.

“These models use a combination of probabilistic ▶

LEFT: A city imagined by AI image generator Midjourney.  
RIGHT: Kellie Nuttall, Deloitte.



**“IT WON’T BE LONG BEFORE ENGINEERS CAN ASK GENERATIVE AI TO OPTIMISE A DESIGN FOR VERY SPECIFIC OBJECTIVES.”**



**“THESE MODELS USE A COMBINATION OF PROBABILISTIC TECHNIQUES, DEEP LEARNING AND NEURAL NETWORKS TO LEARN FROM VAST AMOUNTS OF TRAINING DATA AND THEN GENERATE NEW CONTENT.”**

techniques, deep learning and neural networks to learn from vast amounts of training data and then generate new content that resembles the patterns found in that data.”

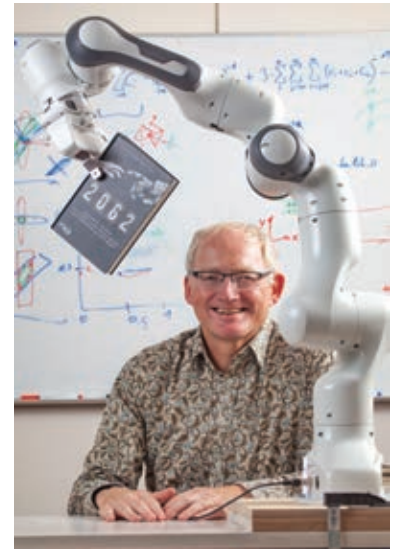
Andrew Hannell, founder of ConstructAI, has specialised in technology in construction and engineering for most of his career. Currently working with the Australian Institute of Machine Learning at the University of Adelaide to build a minimum viable product for automated inspections of major assets such as railways and roads, Hannell said it’s easy right now to dismiss generative AI as a novelty.

“We’ve got a generative AI platform that will produce some sort of weird artwork of a chimpanzee riding a motorbike through the Sistine Chapel, or something like that,” Hannell said.

“That’s fun and interesting, but it’s also not a big leap to say that if you can have a generative AI model that will create novel artworks or literature, the same technology can be extended to engineering to design a structure or a mechanical or electrical system.”

The technology’s possibilities have opened up a new frontier,

RIGHT: Professor Toby Walsh, UNSW.



changing the very nature of the human-machine interface, said University of New South Wales AI Institute chief scientist Professor Toby Walsh.

“ChatGPT is only the beginning of a new way that we’re going to interact with computing



devices and smart devices,” said Walsh, a Professor of Artificial Intelligence at the UNSW Faculty of Engineering.

“We’re going to have conversations where the devices know the context, and can understand quite complex sophisticated commands and requests, and will be able to answer those quite well.”

**ARRIVAL IMMINENT**

Nuttall says that while generative AI is not yet extensively used in engineering and construction, it will not be long before it is adopted.

She expects major engineering software solutions to soon embed generative AI into their platforms the same way Microsoft is adding Copilot into its various Microsoft 365 applications.

At Bluebeam, which develops construction software for engineers, architects and builders, and its parent company



ABOVE: Andrew Hannell, ConstructAI.

Nemetschek Group, the teams across the 13 brands regularly come together to discuss new and emerging technologies specifically related to AI and approaches that could have an impact on their product lines.

“Increasingly the subject of conversation has included generative AI,” said Don Jacob, Bluebeam co-founder and Vice-President of Technology and Innovation of the Build and Construct Division at Nemetschek Group. “At the Nemetschek level and across all the brands, there is absolutely an excitement about generative AI and the potential it brings, because we see applications that over time can transform the industry.

“This is the next evolution. It’s the next set of tools and capabilities that are going to help us do our job.”

Jacob said Bluebeam is actively investigating the topic.

“There is huge opportunity, when you think about the information that lives in the engineering project data,” he said.

“How do we synthesise and make use of this information in a more compelling way? This is where AI and machine learning can have a huge impact on giving us the answer, on uncovering information to consider versus us having to seek it out.” ▶

**“HOW DO WE SYNTHESISE AND MAKE USE OF THIS INFORMATION IN A MORE COMPELLING WAY? THIS IS WHERE AI AND MACHINE LEARNING CAN HAVE A HUGE IMPACT ON GIVING US THE ANSWER.”**

**THE PATH TO GENERATIVE AI**



Mathematician and researcher Dr Claude Shannon publishes a paper describing how a machine could be programmed to play chess, after making the machine at home.

Engineer Edward Albert Feigenbaum founds the Knowledge Systems Laboratory at Stanford University, which develops computer systems with expertise in specific domains such as medicine and finance.

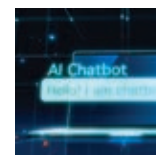
Engineer and computer scientist Ian Goodfellow develops a generative adversarial network that learns to generate new data by pitting two neural networks against each other – one generating new data samples and the other trying to distinguish the generated data from real data.



Over six weeks, a gathering of mathematicians and scientists brainstorm the concept of “thinking machines” at Dartmouth College in New Hampshire. This event, known as the Dartmouth Summer Research Project, is considered AI’s founding event.



Boltzmann machines, which imitate neural networks, are developed and can be taught to recognise patterns in data.



ChatGPT by OpenAI is released.

## OPPORTUNITIES TO COME

Because of the amount of relatively repetitive work that's involved in their jobs, design engineers spend a surprisingly small amount of time designing, Hannell said.

"In my experience, if we're talking about design engineers, the amount of time they actually spend designing could be less than 10 per cent," he said.

"The rest of their work is taking that design and documenting it, coordinating with other disciplines, reviewing, modifying the design and making changes to documentation."

A lot of the opportunities in generative AI revolve around a new capability to have a machine make such changes, as well as optimisations.

"These are things that are time-consuming and expensive," she said.

"Engineers are often selling billable hours and expertise. That's where the threat and the opportunity comes from with an AI-based tool.

"Such a tool can allow a particular task to be done dramatically faster and can produce a significantly better result. It can reduce

## "GENERATIVE AI IS GOING TO CATALYSE THE CREATION OF WHOLE NEW INDUSTRIES THAT EXISTING ENGINEERS WILL NEED TO WORK WITH AS WELL."

over-engineering and therefore cut the cost of materials and the embodied energy.

"Even if it saves just five per cent of cost or 10 per cent of greenhouse gases, on a big project that can be very significant."

Nuttall said one of the most valuable developments in generative AI is that it will be able to explain how or why it came to a particular conclusion or design.

"And so you can actually verify it a little bit better," she said.

"The other thing is that generative AI is going to catalyse the creation of whole new industries that existing engineers will need to work with as well. I don't know if we can imagine what they are yet."

Just as the industrial revolution saw the rise of mechanical ▶

## AI AT THE CSIRO

The CSIRO is fast becoming a portal through which news, information and education around AI-related topics is discovered and distributed.

One example, currently in beta, is the Australian AI Ecosystem Discoverability Platform, a directory of Australian AI capabilities that is far greater than the sum of its parts.

Some of the organisations on the directory include:

- **UNSW Business AI Lab:** working with industry and individual businesses to develop relevant AI-based tools and technologies.
- **WorkingMouse:** an Australian software company specialising in the development of AI-capable solutions.
- **Traversal Labs:** developing data-engineering solutions for heavy industry.
- **Tech Policy Design Centre:** carrying out the vital task of reimagining how governance shapes technology and developing fit-for-purpose tech policy frameworks.
- **Sapia:** bringing humanity back into the automated recruitment process with an AI smart interviewer.



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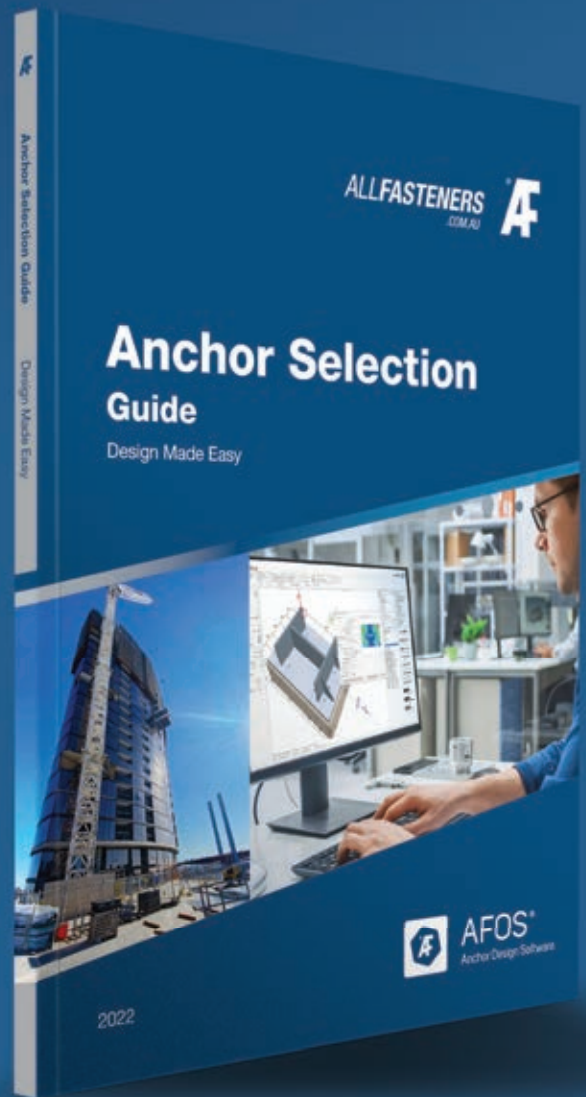
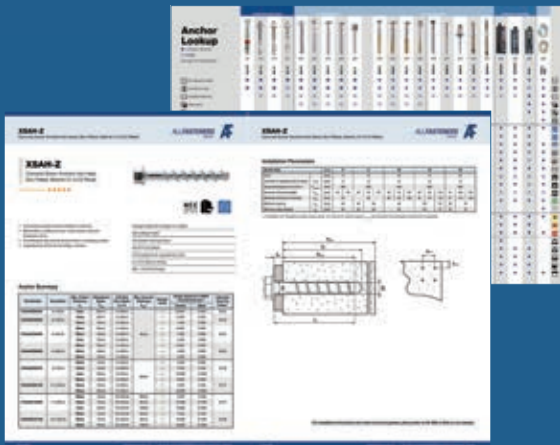




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engineers, the generative AI revolution will have a similar effect, she said.

Generative AI on its own won't necessarily lead to competitive advantage for an organisation, Nuttall explains, because the barrier to entry is quite low.

What will make a difference is the way an organisation uses data sets to develop unique models which, in themselves, become powerful performance differentiators.

**“ENGINEERS HAVE TO BE THINKING ABOUT WHAT THE TECHNOLOGY POTENTIAL IS, SO THAT WHEN IT IS POSSIBLE, THEY CAN START TO RUN WITH IT.”**

#### START POINT

Computational design and modelling tools such as McNeel's Grasshopper and Autodesk's Dynamo have existed for some time, Hannell points out.

“The essence of these applications is that you design the algorithm that designs the thing,” he said.

“The logic, constraints and parameters can be adjusted to produce an infinite number of design iterations, and an optimal solution produced.

“These applications already have some AI-based capabilities such as regression algorithms and neural networks, as well as integration with language models such as ChatGPT.”

These are as good a place as any to start, he said, as there will likely be a convergence of computational design and generative AI over the next few years.

Engineers should also spend time playing around with the general consumer tools that are currently available and figuring out how they work, Nuttall said.

#### IN THE CITY

Autodesk Fusion 360 is a generative artificial intelligence that helps design engineers to calculate the optimum designs of parts, saving time and materials.

This technology is being used by the engineering consultancy EDAG Group in its production of the CityBot, an autonomous, modular vehicle with attachments.

The CityBot is being designed to serve various purposes in urban environments, from garbage collection to passenger transport, and from airport baggage handling to forklifting.

“Having real usage data means our engineers can calculate the specific requirements for, for example, the wheel mount,” said Sebastian Flügel, Project Leader at EDAG Group, in a case study interview with Autodesk.

“The big change [from the old process] is that generative design creates the geometry automatically, and with Fusion 360 we can automatically recalculate these products — and we can create new solutions based on the changed conditions.”

There are a number of advantages to the technology, which begins with the collection of data to develop a digital twin environment from which various decisions are made.

It helps connect workflows and data feeds between the design, testing and manufacturing teams. It removes various manual steps and design iterations, reducing development costs.

And finally, generative AI speeds up the pace of design of the custom parts required to develop such a unique product.



After all, that's what engineers are good at. They should get to know what current generative AI tools are capable of and figure out how they can be stretched.

“Spend time on ChatGPT and Midjourney,” she said.

“The capability for the creation of flyovers and complex engineering plans and digital twins is not available yet in generative AI. But engineers have to be thinking about what the

technology potential is, so that when it is possible, they can start to run with it.

“I get asked a lot about what is the biggest risk here. The biggest risk is being complacent and thinking this isn't going to disrupt your industry — because others in your industry have already started their journey.” ●



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**O**N 30 July 2021, as it was undergoing testing shortly before it was set to be brought online, Victoria's Big Battery caught fire.

Located in Moorabool, near Geelong, the 300 MW/450 MWh battery grid is the largest in Australia, and one of the largest in the world.

At the time, it was using Tesla Megapacks that featured lithium-ion batteries with nickel manganese cobalt (NMC) chemistry.

Two of the 212 megapacks were damaged in the blaze, which burned for more than three days and made headlines around the world.

The phenomenon that causes lithium-ion batteries to catch fire like this is known as "thermal runaway".

Associate Professor Robert Kerr of the Institute for Frontier Materials at Deakin University said this is caused when a battery cell starts to rapidly overheat.

"When you get that heating, at some point the cathode materials will start to release or liberate oxygen; it's an exothermic reaction itself that starts to generate more heat," he explained. "It's self-heating, self-perpetuating, and once it reaches that point, you can't stop it - you get runaway."

A subsequent investigation by Energy Safety Victoria found that the likely cause of the Big Battery fire was a leak within the megapack cooling system, which caused a short circuit and triggered the runaway event.

Thankfully, though, nobody was injured in the fire, and the megapacks are considered to have "failed safely".

Lithium-ion batteries - like those often used in megapacks, and all manner of other devices - are a critical part of Australia's efforts to decarbonise and increase renewable energy storage capacity.

But, as the Victorian Big Battery fire shows, they do pose safety

WORDS BY **KIM THOMSON**

# CHARGED WITH SAFETY

FROM E-SCOOTERS TO SMARTPHONES TO LARGE-SCALE STORAGE GRIDS, LITHIUM-ION BATTERIES ARE EVERYWHERE. BUT SHOULD WE BETTER MANAGE THEIR RISKS?



**ABOVE:** Victoria's Big Battery caught fire in July 2021.

risks, and Australia currently has little regulation governing their usage, storage, and disposal.

In December, the Australian Competition and Consumer Commission (ACCC) released a lithium-ion batteries issues paper, citing the fact there is "no regulatory framework or mandatory safety standard which

squarely addresses the risks with Li-ion batteries in Australia".

Associate Professor Alexey Glushenkov, Research Lead in Battery Materials at the Australian National University's Battery Storage and Grid Integration Program, said, despite the headlines, lithium-ion batteries are generally safe.

"Overall, lithium-ion battery cells are very robust and very reliable," he said. "Having said that, there is a low probability event that some of them might go wrong, and sometimes they do - so we see accidents happening from time to time."

Glushenkov said the lithium-ion proliferation comes down to the fact the batteries can pack a huge amount of energy into a small space.

"They offer the best practical energy density - also called specific energy - which means





**“THEY OFFER THE BEST PRACTICAL ENERGY DENSITY – ALSO CALLED SPECIFIC ENERGY – WHICH MEANS THE AMOUNT OF ENERGY THAT YOU CAN PACK INTO A GIVEN VOLUME OR GIVEN MASS.”**

the amount of energy that you can pack into a given volume or given mass,” he said. “But they do have some flammable components, like carbon electrode materials: for example, organic electrolyte.

“And they are sensitive to abuse, so to speak – you shouldn’t overcharge them, shouldn’t overheat them; sometimes there could be also gas evolution inside ... and there is a possibility of growing lithium dendrites inside of the cell.

“All these sort of abuse types and mechanisms may lead eventually to fire in lithium-ion batteries.”

Glushenkov said most reputable companies ensure high safety standards and testing, but this is not the case for all battery manufacturers.

He added that, while “lithium-ion” is often used as a catch-all term, different lithium-ion battery chemistries have different risk profiles.

The commonly used NMC is a powerhouse when it comes to energy density but poses a greater risk of thermal runaway.

Another common chemistry, lithium iron phosphate (LFP) trades off on density but reduces combustion risk.



**ABOVE:**  
Alexy Glushenko,  
Australian  
National University.

According to a recent report commissioned by the Australian Energy Council into large-scale battery hazards, Tesla has since reconfigured the megapacks in the Victorian Big Battery after the fire at Moorabool and updated them to LFP chemistry.

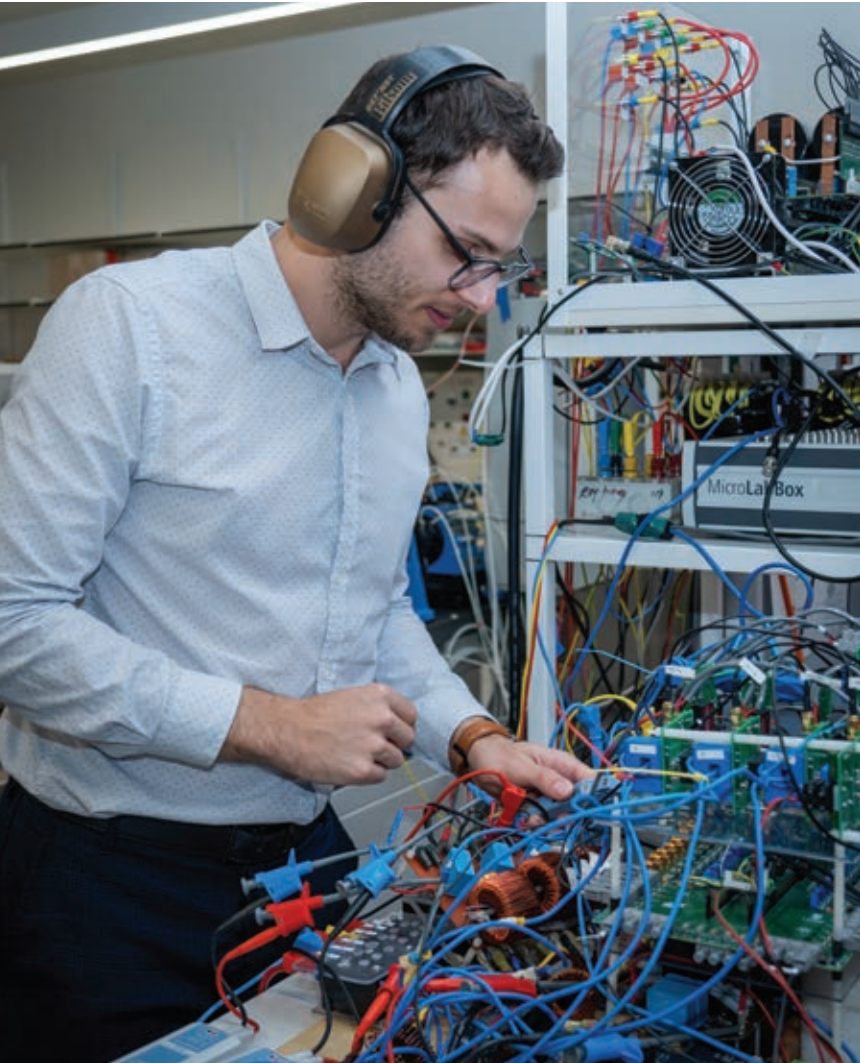
**RISE OF THE BATTERY**

Lithium-ion batteries aren’t used in grid-scale storage; They’re in devices all around us.

The recent rise in popularity of e-mobility vehicles like e-scooters and e-bikes has also brought with it increased reports of battery fires.

As reported by the ABC, the New South Wales fire department logged more than 450 fires related to e-scooters and e-bikes in a recent 18-month period.

Dr Matthew Priestley, Lead Technology Translator at the Digital Grid Futures Institute at University of New South Wales said that while ▶



BELOW (from top): Dr Martin Priestley, UNSW; Associate Professor Robert Kerr, Deakin University.



“The scariest thing is sometimes these warehouses are in suburbia; you wouldn’t even know if there’s one down the road from you if you live in an industrial area.”

Priestley said he’s inspected these facilities and witnessed some worrying practices.

“I was in one a couple of days ago and it had thousands of kilowatt hours of energy storage all sitting right next to each other,” he said.



**“THE CHALLENGE IS: HOW DO YOU DETERMINE WHETHER THAT BATTERY’S SAFE OR NOT? THERE’S A WHOLE HOST OF TESTS THAT GO ALONG WITH THAT.”**

these cases are concerning, proper usage can minimise the risk of fire in these devices.

“At the moment, the public is only thinking of battery safety in regard to e-bikes, because that’s what they’ve been told in the media is potentially dangerous,” he said. “What we’re finding in the e-bike sector though is if you use a charger that’s actually been designed for the bike, follow the manufacturer instructions on safe usage, and you’re using a reputable e-bike – not one that you built yourself – the risk of battery failure is very low.”

What’s much more concerning, Priestley said, are aspects such as the current storage and disposal practices of high-energy lithium-ion batteries in Australia.

### STORAGE ISSUES

Priestley said one concerning area his team is investigating is how high-energy batteries are stored in Australia.

“When we bring these batteries in from overseas where they’re manufactured, we have to put them somewhere; at the moment, some companies are storing them in warehouses – without properly considering the safety implications,” he said.

“These warehouses are often rated to carry dangerous goods, but they’re not really rated, in my view, to take the total level of energy lithium-ion batteries that are there – particularly when some of these batteries require storage at 30 to 50 per cent state of charge.

If a forklift accidentally pierced one of those, disaster could result.

“We asked them what they would do in that situation – if one of these batteries was to light up,” Priestley said.

“Their answer was: we’d move it outside – but there’s no way that you can safely move one of these outside once the battery moves into thermal runaway.”

Priestley pointed out these practices are currently perfectly legal due to a lack of regulation.

“None of the stuff I’ve seen is technically illegal – but it’s unsafe,” he said.

He said it’s important to note that most reputable high energy lithium-ion battery companies are taking proper safety precautions when storing their products.

ABOVE LEFT: Priestley testing battery safety. ABOVE RIGHT: Use of e-scooters is increasing demand for electric batteries.

“However, some cheaper brand competitors appear to be hoping nothing goes wrong and not designing any procedures for if something does go wrong.”

### DISPOSAL DANGERS

Another area of concern is the disposal of spent batteries.

Priestley’s team has been talking to operators in the e-bike sector about their current battery disposal practices.

“They’ve been told by so-called battery experts ... to just tape up the terminals and throw them in 160 L wheelie bins for disposal collection. Now that’s just not good enough,” he said. “When I asked, were they discharging the batteries to a safe level? The answer was, in some instances: maybe not.”

Priestley said incorrect discharging of battery terminals could lead to big problems.

“In that situation, all it would take would be if you’ve got a battery with some charge remaining that touches another battery with terminals that haven’t properly been isolated or taped up,” he said. “Now you’ve had a short circuit and potentially a fire and dangerous situation.”

He said there’s also currently no standard practice for the disposal of faulty lithium-ion batteries.

### BETTER DESIGNS

Future advances in materials and chemistry might one day complement lithium-ion batteries.

Associate Professor Alexey Glushenkov’s team is researching batteries that use more sustainable materials, such as sodium-ion, potassium-ion and dual-ion batteries.

He said adjustments to li-ion can increase fire safety, though with trade-offs in energy density.

“Further modifications are possible for lithium-ion batteries ... one can also replace negative electrode graphite with a different material called lithium-titanate – often referred to as LTO,” he explained. “They have even better fire safety ... you can basically deform them, you can drill through them, you can push nails through them, you can cut them, and they do not tend to catch fire.”

BELOW: The Australian National University’s Battery Storage and Grid Integration Program battery lab.

**“WE DON’T HAVE THAT LEVEL OF INTUITION WITH BATTERIES AT THE MOMENT, DESPITE THE FACT THEY HAVE A SIMILAR RISK LEVEL.”**

“I’ve seen some companies throw them in big containers full of sand. But there’s no unified approach, as every battery product is different.”

### INCREASING SAFETY

Despite the safety concerns, lithium-ion batteries are a crucial tool – and one we’re likely going to increasingly rely on.

Priestley said he’d like to see government regulation catch up to match the risks.

“The regulation is very non-prescriptive. Legally, we can store these things in cardboard boxes,” he said.

He said UNSW hopes to form a national working group underpinning a more coordinated approach to battery safety.

“What we’re seeing at the moment is every institution is doing their own research and has their own way of doing things. It means there’s a lot of duplication of work,” he said.

“We actually need a centralised approach and in particular centralised data collection on issues with lithium-ion batteries to dispel any myths surrounding these products.”

Better onshore testing facilities may also play a role in increasing safety. Kerr said Deakin University’s Battery Research and Innovation Hub is ramping up testing capability.

Priestley also wants to see greater public awareness of battery risks.

“We’ve been used to petrol and how dangerous petrol can be when used the wrong way,” he said.

“But we don’t have that level of intuition with batteries at the moment, despite the fact they have a similar risk level, if not higher.”

And, despite the challenges, Priestley is optimistic about the future state of play – and doesn’t want to warn people off lithium-ion altogether.

“Although lithium-ion batteries have these risks, they are a really good way of decarbonising our economy.” ●



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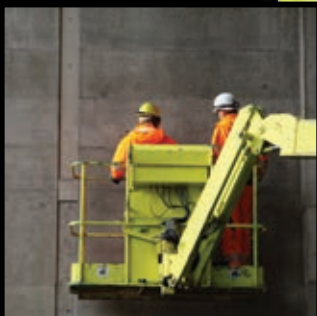
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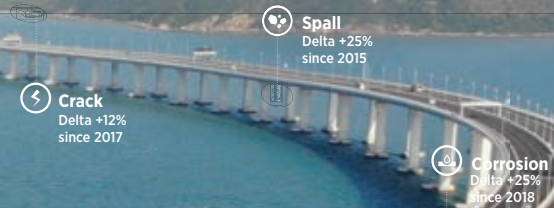
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WORDS BY NADINE CRANENBURGH

# THE VIEW FROM ABOVE

THE TENSION CREATED WHEN A CHINESE BALLOON WAS SHOT DOWN OVER AMERICAN AIRSPACE HIGHLIGHTS THE GROWING INTEREST IN LIGHTER-THAN-AIR TECHNOLOGY FOR MILITARY AND CIVILIAN APPLICATIONS.

**I**N A flashback to the Cold War earlier this year, a giant Chinese balloon – packed with instrumentation – drifted over US airspace.

Recently leaked Pentagon documents suggest the balloon was equipped with synthetic aperture radar (SAR) and its solar panels could generate up to 10,000 W of power, which the leak considered “excessive for a weather balloon”.

SAR can resolve objects and terrain – even see through thin materials, like tarps – at night and through clouds, and generates images and other information with high precision and resolution.

But China isn’t the only nation setting balloons afloat.

There are a number of projects underway in Australia and on the global scene that use the technology for communications, intelligence gathering and “friendly” surveillance, such as monitoring of crops and natural disasters.

## STRATOSPHERIC AMBITIONS

Robert Brand started experimenting with high-altitude balloons in 2011, motivated by a desire to inspire his then nine-year-old son, Jason.



PICTURED:  
Flight Design's  
StratoDrone.

Their first balloon reached just over a quarter of the way to space, bursting at an altitude of almost 85,000 feet above West Wyalong, in the Riverina region of New South Wales.

Twelve years later, Jason has become the CEO of the Brands' space and aviation start-up, Flight Design. Last year, aged just 19, he became the youngest person to win the National Australian Industry and Defence Network Young Achiever Award.

sensors into the atmosphere quickly and cost-effectively, giving our forces comprehensive data in the air, on the ground, or at sea," said Linda Reynolds, the Australian Minister for Defence at the time.

Since then, the Brands have sent up test balloons with a range of payloads, including hyperspectral cameras, which provide images that "slice up" the visible light spectrum into narrow bands for highly accurate detection and identification of objects on the ground.



BELOW: Robert Brand, Flight Design.



LEFT: Thunderstruck Space partnered with the RAAF in 2020 for a balloon test flight.

is between the troposphere and the stratosphere, or about 16 to 18 km above the ground.

"The wind there is usually 8 to 10 knots – almost nothing," Brand said, adding that there may be the occasional strong gust which could cause damage or set balloons off course.

#### USES AND BENEFITS

So why use balloons rather than satellites or drones?

There are two reasons: lower cost and, in the case of airships or balloons with propulsion, power and control – the ability to provide continuous coverage of a target area for weeks or even months, and get much closer to a target than a satellite in geostationary orbit.

Uncrewed airships, planes and balloons with the ability to maintain a set position are known

**"HAVING THESE HIGH-ALTITUDE BALLOONS AS PART OF AUSTRALIA'S SOVEREIGN CAPABILITY MEANS THAT WE COULD DEPLOY ADVANCED SENSORS INTO THE ATMOSPHERE QUICKLY AND COST-EFFECTIVELY."**

"What started out as a fun thing to do became a business," Robert Brand told *create*.

He approached defence officials and formed a partnership to get balloons into the stratosphere, the region of the atmosphere above controlled airspace.

In 2020, Flight Design's sister company, Thunderstruck Space, partnered with the Royal Australian Air Force (RAAF) for a balloon test flight with a payload of sensors and communications equipment.

"Having these high-altitude balloons as part of Australia's sovereign capability means that we could deploy advanced

This could have applications in the battlefield, as well as civilian uses in such domains as agriculture and geology.

While Flight Design's current test flights use small latex weather balloons, the company is working towards a balloon almost as large as China's spy balloon.

Known as "StratoDrone", it will have its own fluidic propulsion systems to allow for steering and control, which work as "air multipliers", in a similar way to Dyson bladeless fans.

Brand explained that the StratoDrone will stabilise in a sweet spot for balloon flight: the tropopause, which



ABOVE: Dr Peter Layton, Griffith Asia Institute (top); Dr Dennis Desmond, University of the Sunshine Coast.

as high-altitude pseudo satellites, or HAPS, and have been described by the European Space Agency as the "missing link" between drones flying closer to the ground and satellites in space.

According to Dr Peter Layton, an aviation and defence expert at the Griffith Asia Institute and the UK's Royal United Services Institute, a convergence of technologies has led to a resurgence of interest in stratospheric balloons and HAPS.

"Twenty or 30 years ago, payloads were around 20 kg. Now they can be measured in grams," he said. "There are also more ways of transmitting ▶

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information – communications links and the internet are much better, and materials are more durable.”

But Layton added that increased knowledge of stratospheric winds was the most important factor: “Solar-powered motors are still at the mercy of the environment.”

Dr Dennis Desmond, a former senior intelligence officer in the US military, is now a cyber security lecturer at the University of the Sunshine Coast. He told *create* that additional benefits were the ability to bulk manufacture high-altitude balloons and “fire and forget” them to obtain continuous surveillance streams.

And surveillance can go beyond military intelligence, he said: “Friendly intelligence to monitor bushfires and climate change is extremely important.”

Balloons could also be used to monitor hard-to-detect movements of people – whether soldiers or migrants and refugees – as well as monitor food production and storage.

As well as surveillance, HAPS and balloons can be used for communications and to improve internet coverage in remote areas. This can have both military and civilian applications.



**“TWENTY OR 30 YEARS AGO, PAYLOADS WERE AROUND 20 KG. NOW THEY CAN BE MEASURED IN GRAMS.”**

One Australian company looking to move into this space is Queensland start-up Stratoship, run by electronic and aerospace engineer Daniel Field.

The company has worked with partners including the RAAF Air Warfare Centre, Melbourne’s RMIT University and the Adelaide-based SmartSat Cooperative Research Centre to develop and test a prototype stratospheric airship with propulsion and control.

Last year, the company launched a fully functional prototype to 8000 feet (2.4 km) and is currently running trials

**ABOVE:** Aerostats are surveillance platforms used by the US military in Iraq and Afghanistan.

**BELOW:** Daniel Field, Stratoship.



## History repeats

The use of balloons for military communications and surveillance has a long history, dating to the hydrogen balloons used in 1794 during the French Revolution.

In the 1860s, tethered balloons gave lookouts in the US Civil War a bird’s-eye view of the battlefield. During World War I, telephone wire ground links from observation balloons were used by both sides to direct artillery in real time, making them sought-after targets.

Airships played a role in both world wars. For example, blimps, dubbed “K-Ships”, were used by the US Navy during WWI to spot submarines, and direct the fleet to their location.

Barrage balloons, tethered to the ground using explosive-spiked metal wires, were also arranged in “nets” around strategic targets. These nets were deadly to fighter planes and effective against aerial bombardment.

The Cold War saw the introduction of uncrewed, high-altitude surveillance balloons on both sides of the Iron Curtain. A joint Australian and US project known as “Hibal” also sniffed out nuclear weapons development in other nations using atmospheric testing equipment deployed at altitudes greater than 98,000 feet.

to prove its control system and seeking commercial customers.

At the Avalon Airshow PitchFest in March, Field said deploying the Stratoship as a communications platform could replace the private radio networks and provide coverage for defence, mining and transport users.

There are more than 20,000 registered ground stations in Australia alone, and hundreds of thousands worldwide. He estimated the annual lifecycle cost of a medium network as \$5 million to \$15 million.

“We put the ground station on our helium balloon high in the ▶

stratosphere ... and this extends our range out to hundreds of kilometres,” Field said.

“And unlike certain Chinese spy balloons, we don’t just drift with the wind; we have propulsion and control to stay in place.”

Brand also sees communications as a prime application for the StratoDrone when it is developed.

“We could have StratoDrones 400 km apart communicating as a relay to reach the ground,” he said. “It could be a self-sealing network and stay above cyclones and other nasty weather.”

Internationally, Airbus Defence and Space launched a subsidiary company in July 2022 to provide commercial internet connectivity using its Zephyr HAPS.

The Zephyr was tested at Woomera in South Australia in 2015 and 2018, and operates at an altitude of 64,960 feet with a

**BELOW (from top):** Inflation test of the HAPS Challenge Stratoship prototype; the prototype readying for launch at the Queensland Flight Test Range in Cloncurry.

communications range of 7500 km<sup>2</sup>. It has a winged design and is solar-powered with backup batteries.

In August 2022, the Airbus Zephyr S completed a test flight of over 64 days, which earned it the record for the longest uncrewed, continuous flight.

### CHALLENGES AND THREATS

While they may be an economical way to collect intelligence, current stratospheric airships ▶



### Taming the swarm

The Firefly Pathfinder project, run by RMIT, is validating cooperative positioning algorithms for balloons that were first developed for UAVs, using simulation and real-world balloon flights.

The balloon flights are used to collect platform dynamics data and to assess some aspects of payload control and performance in conjunction with the RAAF’s Plan Jericho, a defence-centred disruptive innovation program.

The algorithm could also be used in bushfire monitoring and for early warning.

IMAGE: STRATOSHIP





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and balloons have a hard time going incognito due to their size.

As seen in the balloon dispute over North America, they can be spotted by the untrained eye and have diplomatic ramifications.

“Balloons might only be viable during periods of peace, or over your own territory,” said Layton.

Smaller, weather-balloon sized craft could be viable and expendable alternatives, he added, as they are slow moving and difficult to pick up on radar. However, these would be at the mercy of the environment unless they were in a low-wind area.

Desmond said agencies such as the North American Aerospace Defense Command, or NORAD, have also gotten better at detecting and jamming balloons and low-flying drones.

They are also easy to identify and shoot down. Image quality can be affected by the weather, unless they are equipped with infrared cameras or SAR.

The good news is that Australia should be equipped to take down any hostile high-altitude balloons that breach its borders using missiles from existing fighters.

Australian Strategic Policy Institute senior analyst Malcolm Davis told *The Guardian* that F-35s could use a “zoom climb” to reach the required altitude.

Balloons can also be vulnerable to attacks from uncrewed aerial vessels (UAV) such as drones, Brand said.

Consequently, he’s developing a high-altitude winged drone which he will pitch to the RAAF

as an alternative to shooting spy balloons down with missiles.

“Missiles are very expensive, at around \$400,000. Drones are much cheaper,” he said, adding that the winged drone could be lifted into the stratosphere by the StratoDrone, and drift downwards on patrol for hostile balloons.

**BELOW:** Flight Design tests its UpLift50 balloon, which improves on the stability of previous designs.

**“MISSILES ARE VERY EXPENSIVE, AT AROUND \$400,000. DRONES ARE MUCH CHEAPER.”**



## THE FUTURE

There is a lot of promise in the current developments in high-tech balloons and airships in Australia, but they are not yet at the stage of commercial adoption – although Stratoship is getting close.

Brand says his development of the StratoDrone has been hampered by the COVID-19 pandemic and the recent intense weather during the La Niña cycle.

“It’s hard to say when we will get one in the air,” he said, although Flight Design still believes there is a viable business case for StratoDrone, particularly in the communications space.

Layton is more sceptical about the case for high-altitude balloons for defence applications, believing that nanosatellites or drones may often be a better option, as they are harder to detect and unlikely to cause international incidents.

On the international stage, Layton says that for balloons to be an option outside of domestic air space, the global community will need to agree to new laws that do not classify balloons travelling under 60,700 feet (18.5 km) above a country as a threat to national security.

“This may be appealing, as they have a much lower cost to launch than satellites,” he said.

But he does see the use of AI to combine data from many balloon payloads as an exciting prospect.

“You could launch 1000 balloons over a space of interest and gain useful information when the data is filtered through AI,” he said. ●

WORDS BY ELLE HARDY

AMBITIOUS WETLAND HABITAT RESTORATION PROJECTS COULD USHER IN A BRIGHT FUTURE FOR NATURAL CARBON SEQUESTRATION AND STORAGE.

**T**HEY ARE Earth's natural carbon sinks – living coastal ecosystems such as mangroves, salt marshes and seagrass beds – that can store up to four times the amount of carbon compared to mature tropical rainforests.

Initiatives to restore living coastal ecosystems – collectively known as “blue carbon” – are becoming powerful weapons in the race to combat rising greenhouse gas emissions.

Not only do they sequester carbon dioxide faster than terrestrial forests and hold it for much longer, but they also protect against coastal erosion and other direct effects of climate change.

While coastal habitats cover two per cent of the ocean's surface and store around half of the total carbon sequestered in ocean sediments, they are also some of the most threatened ecosystems on Earth.

Globally, some 90 per cent of wetlands has been lost since 1700, with around 70 per cent of destruction occurring since 1900. At the current rate of destruction, 40 per cent of the remaining tidal marshes and seagrasses could be lost over the next century, along with almost all the remaining unprotected mangroves.

Destruction of these habitats – through drought, overfishing and urban development – can be catastrophic for both the local environment and community, but it can also drive up carbon emissions.

Two severe cyclones in the Gulf of Carpentaria in 2018 and 2019 that decimated important mangrove forests resulted in more than 850,000 t of carbon released into the atmosphere – the equivalent of about 2000 commercial flights from Sydney to Paris.

# GREEN LIGHT FOR BLUE CARBON

IMAGE: TINO HEIMHUBER

With the ocean's ability to capture carbon dioxide from the atmosphere gaining increasing attention around the world, the Australian government announced \$9.5 million last year to support five new practical restoration projects in blue carbon ecosystems in Queensland, South Australia and Tasmania, and a further \$3 million for four projects in Indonesia and Papua New Guinea.

At the 2022 United Nations Climate Change Conference in Egypt, the CSIRO, the Department of Foreign Affairs and Trade, and Google Australia unveiled a collaboration relying on machine learning to model blue carbon in the Indo-Pacific and along Australia's coastline as part of the tech giant's Digital Future Initiative.

"Australia has one of the longest coastlines on Earth and is home to about 12 per cent of the world's blue carbon," said Minister for the Environment and Water Tanya Plibersek when she announced the funding for the Indonesia and Papua New Guinea projects.

"So we very much understand the importance of protecting, restoring, expanding these environments."

#### LAY OF THE LAND

A number of other blue carbon projects are underway, with universities and research organisations still learning best practices for a term that was only first coined in 2009.

Given that valuing blue carbon sequestration may help encourage restoration projects, rigorous methods are required to quantify the amount of blue carbon sequestered in coastal wetland restoration.

"The first blue carbon method that can be implemented through Australia's Emission Reduction Fund is tidal flow restoration to areas where the tide has previously been restricted," said Dr Paul Branson, an engineer



## "AUSTRALIA HAS ONE OF THE LONGEST COASTLINES ON EARTH AND IS HOME TO ABOUT 12 PER CENT OF THE WORLD'S BLUE CARBON."

and coastal oceanographer with the CSIRO.

Branson is working on a \$3.3 million, 30-month mission estimating Australia's blue carbon potential, where researchers will measure and quantify the emissions reduction capacity of Australia's mangroves, seagrasses and tidal marshes.

"In many locations, coastal saltwater marshes have been banded for salt production

**ABOVE (clockwise from top):** Blue-carbon ecosystems at Mangrove Bay, Exmouth, Western Australia; Dr Paul Branson, CSIRO; a mangrove root structure.

or drained for grazing or agricultural purposes," he said.

"The changes in the hydrology of these systems results in the loss of coastal ecosystems and release of carbon due to soil degradation. Through reconnecting the tidal hydrodynamics and flushing, coastal ecosystems are able to re-establish, allowing the system to become a net carbon sink.

"The tidal re-introduction process typically involves land surveying, hydrological studies and engineering earthworks to remove bunds and tidal restrictions."

Describing the joint CSIRO and BHP project as "ambitious", Branson said that his role as a coastal engineer is twofold.

"Firstly, to use models and measurements of water levels ▶



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around Australia to estimate mean sea level and tidal planes relative to a national vertical datum. These water levels feed into models that estimate the current and potential future carbon abatement, whilst also considering land uses and future sea-level rise," he said.

"The second component is assessing the coastal risk reduction benefits that these systems provide through the attenuation of waves and storm surges."

In setting out to answer how long blue carbon projects can take to see meaningful change, Branson cautioned that it is only possible with further investment, including in helping proponents

## "THROUGH RECONNECTING THE TIDAL HYDRODYNAMICS AND FLUSHING, COASTAL ECOSYSTEMS ARE ABLE TO RE-ESTABLISH, ALLOWING THE SYSTEM TO BECOME A NET CARBON SINK."

collect the necessary data from multiple sources, learning from past projects and improving engineering design to enhance the recolonisation process.

"We currently don't have a national-scale estimate of the potential of blue carbon, or land

ABOVE (from left):  
The Climateworks  
Centre team;  
Climateworks  
SEAFOAM  
project engineer  
Minalee Busi.

available for tidal re-introduction," he said.

"If the hydrological conditions are right, and seeds available or replanting undertaken, mangrove biomass can increase quite rapidly over the first 10 years."

Pilot projects are currently underway, and monitoring has demonstrated that soil carbon levels can increase after only two to three years.

"However, the overall re-establishment process is long term, which is why the Emissions Reduction Fund method considers timescales of up to 100 years," he said.

### REGIONAL INVESTMENT

Minalee Busi is a systems engineer and analyst on the Climateworks Centre's Southeast Asia Framework for Ocean Action in Mitigation, or SEAFOAM, project, which is using Indonesia as a pilot project in trying to understand the climate change mitigation potential of the ocean, including blue carbon ecosystems.

"It's a mapping exercise in terms of understanding where these ecosystems exist in and around Indonesia," she told *create*. "We're also analysing the emissions reduction potential of these ecosystems as well as highlighting gaps in the data that currently exist."

Using an application called ArcGIS to map these ecosystems across Indonesia, the project aims to provide policy recommendations to the Indonesian government, which will be able to demonstrate its leadership in protection and restoration of these sites.

"There's been a lot of focus on mangroves as an important blue carbon sink, but we have found much less attention and prioritisation given to seagrass ecosystems," Busi said.

One challenge is that there are many disparate sources of information, and the aim is to present the most up-to-date and

### OUT OF THE BLUE

Blue carbon is seen as the next big thing in carbon crediting, and in January 2022 Australia's Clean Energy Regulator's tidal restoration of blue carbon ecosystems method came into effect. Commonly referred to as the "blue carbon method", it enables Australian carbon credit units – ACCUs – to be earned by projects that remove or modify tidal restriction mechanisms and allow tidal flow to be introduced to an area of land.

The method provides incentives for landholders to restore coastal

wetland ecosystems that have been completely or partially drained by reintroducing the tide to lands where tidal influences have been reduced by installed barriers, and enabling the conversion of freshwater wetlands to brackish or saline.

Anyone wishing to claim the blue carbon credits must complete appropriate hydrological assessments and work with a qualified engineer on a project operations and maintenance plan.

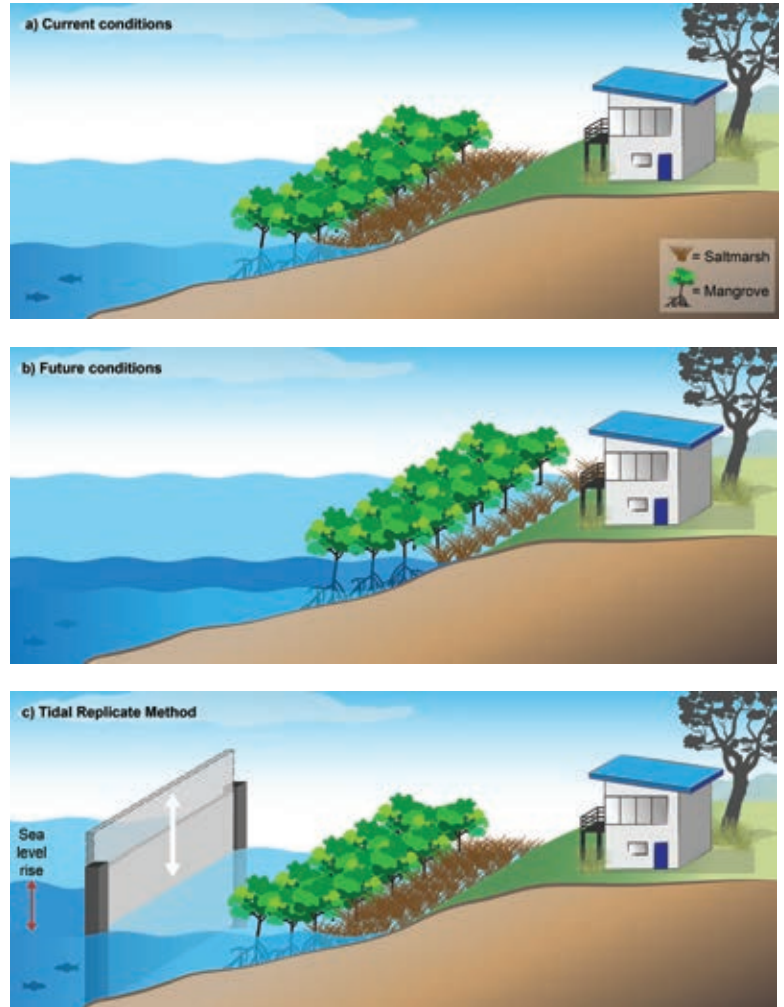
accurate data by focusing on ground truth validated data. This includes the sediment carbon storage potential of seagrass ecosystems, for example, to understand the actual potential of carbon storage of these ecosystems, as well as quantifying the climate change mitigation potential from protection and restoration of these ecosystems.

“We hope to increase ocean-climate literacy by providing information about the importance of these ecosystems in mitigating climate change, and work with on-ground partners in the future to improve technical expertise required for the development of these



LEFT: Toby Tucker, the University of New South Wales.

## PROTECTING WETLANDS FROM RISING SEA LEVELS



projects,” Busi said. “We are beginning to see huge interest from financial institutions, who are understanding the value of oceans and blue carbon ecosystems for a low carbon environment, as well as the role they play in provisioning financial incentives required to make these projects self-sustaining.”

### CONCEPTUAL ENGINEERING

At the University of New South Wales’s Water Research Laboratory, Toby Tucker CPEng is a senior engineer looking at wetland hydrology and the hydraulic design of wetland systems.

**“THERE’S BEEN A LOT OF FOCUS ON MANGROVES AS AN IMPORTANT BLUE CARBON SINK, BUT WE HAVE FOUND MUCH LESS ATTENTION GIVEN TO SEAGRASS ECOSYSTEMS.”**

“My work on coastal wetland restoration and coastal floodplains has looked at the loss of these environments since European settlement,” he told *create*. “They’ve been over-drained and there hasn’t always been a lot of thought put into what these habitats actually provide for the environment.”

After first coming to the field through work on severely degraded coastal floodplain systems, he now works on blue carbon by calculating how engineers can manipulate what was formerly agricultural or poorly drained systems and how we can change how water flows across those sites to create new habitats.

One key project he has been involved in is the Yeramba Lagoon in the Georges River in the south-west of Sydney.

About 80 years ago, construction of a roadway disconnected the lagoon from the estuary, and this has seen

the waterway suffer an accumulation of contaminants and poor tidal flushing.

“In that time, lots of runoff from the urban environment saw a dense weed mat grow across the site,” he said.

In looking for ways to restore the lagoon to its former state, engineers at the laboratory conducted numerical modelling, which informed the design of what needed to be done to restore the area. Tucker is now monitoring the system following its restoration to assess how successful they have been at getting the tide back into the system.

“Part of our work was understanding if we could create the right hydrological conditions for blue carbon habitat to grow, since when blue carbon vegetation like saltmarsh mangrove and seagrass grow, they capture carbon,” he said.

Lagoon on incoming tides and establish new vegetation.”

Tucker describes this kind of engineering as “conceptual”, in that he considers how the site behaves in terms of hydrology and hydraulics, and what changes are needed.

On projects such as the Tomago Wetland restoration project in the lower Hunter River estuary of New South Wales, he works closely in conjunction

with other engineers who determine design, materials and construction.

“Researchers are looking at the wetlands’ capacity to take nutrients and carbon through the groundwater as well as the surface water,” he said.

“One of the big themes in blue carbon recently is not only focusing on carbon capture, but the other ecosystem services and co-benefits that are provided by coastal wetland habitats.

“There’s a lot more benefit to be gained than just the carbon that’s been stored – such as removing nutrients from the waterway, increasing biodiversity, establishing good fishery nurseries, and flood protection by attenuating wave energy or acting as storage basins for flood events.

“It’s so exciting that blue carbon is a pathway towards recognising the value of coastal wetland habitats.” ●

**BELOW (from top): Yeramba Lagoon, Georges River; Tomago Wetland restoration, Hunter River.**



## “RESEARCHERS ARE LOOKING AT THE WETLANDS’ CAPACITY TO TAKE NUTRIENTS AND CARBON THROUGH THE GROUNDWATER AS WELL AS THE SURFACE WATER.”

Some blue carbon habitats are harder to establish than others, with seagrass meadows in particular requiring a lot of additional work compared to mangroves.

“At Yeramba, this hydrological assessment was completed as part of the numerical modelling,” Tucker said.

“Importantly though, there are other blue carbon habitats on the Georges River nearby, so their seeds can flow into Yeramba



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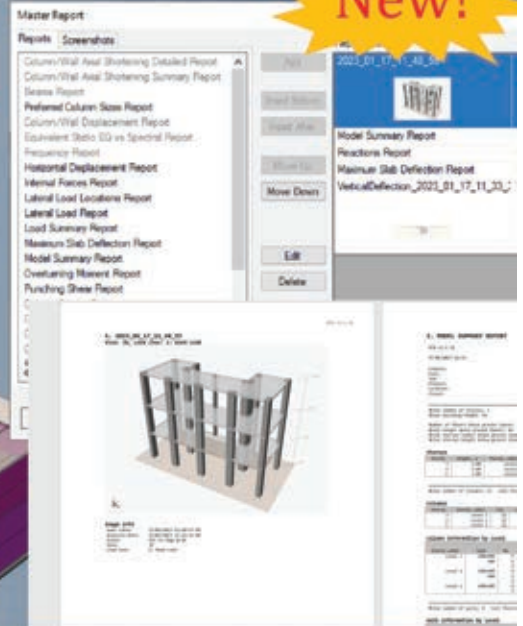
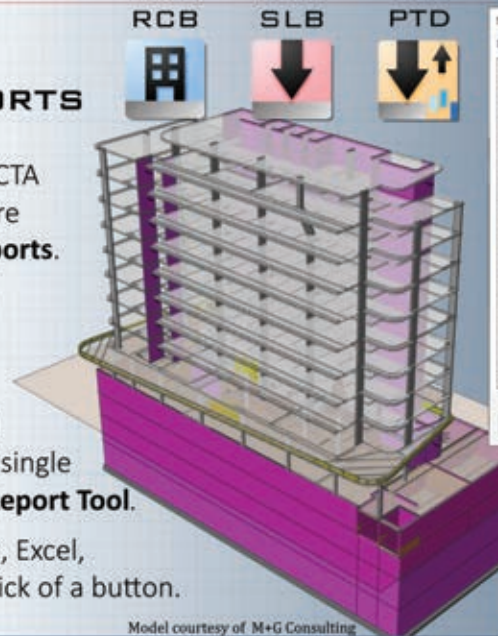
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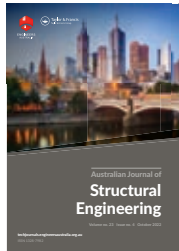
HIGHLIGHTS FROM AUSTRALIA'S MOST UP-TO-DATE ENGINEERING RESEARCH



**HOW THE COVID-19 PANDEMIC RESHAPED DEMOGRAPHIC VARIATION IN MENTAL HEALTH AMONG DIVERSE ENGINEERING STUDENT POPULATIONS**

**Journal:** *Australasian Journal of Engineering Education*  
**Authors:** A. Danowitz & K. Beddoes

With the onset of COVID-19, many residential universities switched to a remote learning model, fundamentally changing the relationship between students, campus and family support. This work uses survey data to explore how COVID-19 affected mental health issues among students from different backgrounds.



**INFLUENCE OF PITTING CORROSION PARAMETERS ON THE RESIDUAL FATIGUE LIFE OF A STEEL CABLE**

**Journal:** *Australian Journal of Structural Engineering*  
**Authors:** L. Cai, W. Zhang, Z. Long & Z. Liu

Corrosion wastage is a significant factor that leads to load-bearing capacity degradation of cable steel wire structures. This paper studies the influence of pitting corrosion parameters on the residual fatigue life (RFL) of a steel cable, to fit a series of formulas to predict the RFL of steel cables. The results show that stress concentration factors increase with the increase of pit depth and decrease with the increase of pit width.



**NEW CONTRIBUTIONS FOR SPEED OBSERVATION OF ASYNCHRONOUS MOTOR FED BY MULTILEVEL INVERTER**

**Journal:** *Australian Journal of Electrical and Electronics Engineering*  
**Authors:** S. El Daoudi, L. Lazrak & N. El Ouanjli

Control fulfilment of asynchronous motors requires accurate feedback of speed information. Previously, this function was attributed to mechanical sensors; however, due to the limited use restrictions, scientists have developed a variety of speed observation algorithms. This paper proposes three new structures of observers to achieve an efficient behaviour at low and high speeds.



## Design and analysis of smart assistive humanoid robot for isolated patients

**Journal:** *Australian Journal of Mechanical Engineering*  
**Authors:** D.J. Sut & P. Sethuramalingam

In general, smart assistive robots can help patients and healthcare staff, and particularly make the anticipation, containment and exacerbation of coronavirus easier by highlighting the virus's burden on healthcare structures during a crisis. In this type of situation, a smart-assistive robot with aid capabilities is a promising prospect, especially for those putting their lives in jeopardy by interacting with ill patients in hygienic environments. This paper discusses a robot with a wheeled base and a humanoid structure that can aid isolated patients and connect wirelessly anywhere in the world more effectively without any physical touch.

**BELOW RIGHT:** Various perspectives of an entirely constructed robot structure.



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CONFERENCES & EVENTS | JUNE - NOVEMBER 2023

<p><b>19-21</b> JUN 2023 CONFERENCE ON RAILWAY EXCELLENCE 2023 (CORE)</p>	<p><b>Location:</b> in-person <i>Melbourne</i> <b>Website:</b> <a href="http://core2023.org">core2023.org</a> The premier technical conference in Australasia's rail industry calendar is celebrating 25 years in motion. This year will highlight the technological and industry developments that are increasing and enhancing the effectiveness of rail. <b>Register now</b></p>
<p><b>15-18</b> AUG 2023 AUSTRALASIAN COASTS AND PORTS</p>	<p><b>Location:</b> in-person <i>Sunshine Coast</i> <b>Website:</b> <a href="http://coastsandports2023.com.au">coastsandports2023.com.au</a> "Working together: 50 years of coasts and ports" is the conference theme for 2023. The conference will bring together professionals to focus on the technological, scientific, policy, planning and design issues related to our diverse and developing coasts. <b>Register now</b></p> 
<p><b>07-08</b> SEP 2023 RISK ENGINEERING CONFERENCE 2023 (RISK 2023)</p>	<p><b>Location:</b> in-person <i>Brisbane</i> <b>Website:</b> <a href="http://engineersaustralia.org.au/risk2023">engineersaustralia.org.au/risk2023</a> The conference theme for the 10th International Risk Engineering conference is "Risk engineering for a resilient 2030". It will bring together a wide range of engineering professionals and disciplines practising engineering-related risk management, risk analysis and risk-based decision-making processes when undertaking engineering activities. <b>Register now</b></p>
<p><b>11-13</b> OCT 2023 SEVENTH WORLD ENGINEERS CONVENTION</p>	<p><b>Location:</b> in-person <i>Prague, Czech Republic</i> <b>Website:</b> <a href="http://wec2023.com">wec2023.com</a> This international event will bring together engineers, scientists, technical specialists as well as industry executives, policymakers, educators and students to exchange views and mobilise their crucial role in contributing to solving the most critical global problems of humanity. <b>Early bird registrations close 15 July 2023</b> <b>Register now</b></p>
<p><b>07-09</b> NOV 2023 IMC INTERNATIONAL MARITIME CONFERENCE</p>	<p><b>Location:</b> in-person <i>Sydney</i> <b>Website:</b> <a href="http://indopacificexpo.com.au">indopacificexpo.com.au</a> The IMC International Maritime Conference invites delegates to be involved in discussions concerning the latest developments in naval architecture, marine engineering and maritime technology in the areas of both defence and commercial shipping. <b>Save the date</b></p> 

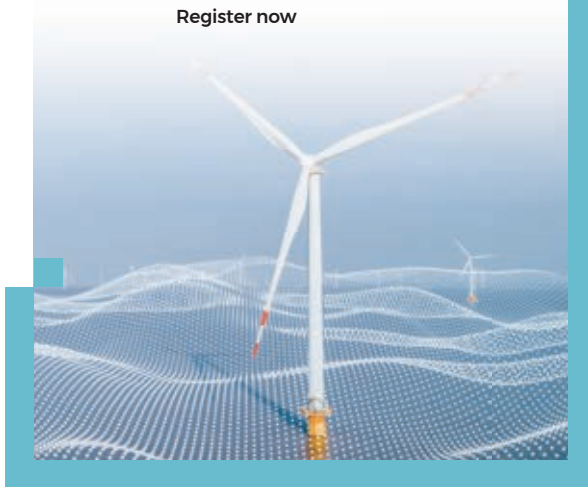
**29-30**  
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**Climate Smart Engineering Conference 2023**

**Location:** in-person *Melbourne*  
**Website:** [engineersaustralia.org.au/cse](http://engineersaustralia.org.au/cse)

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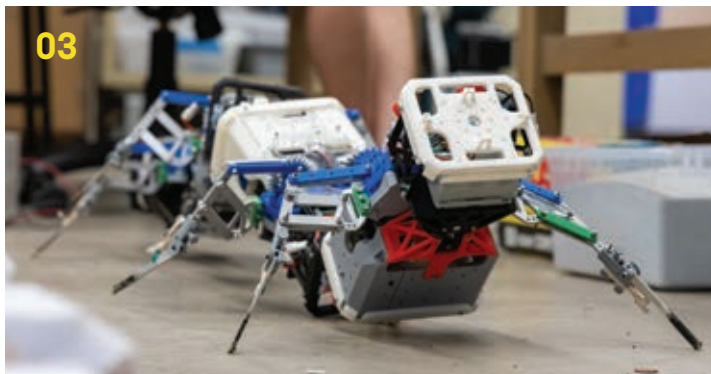
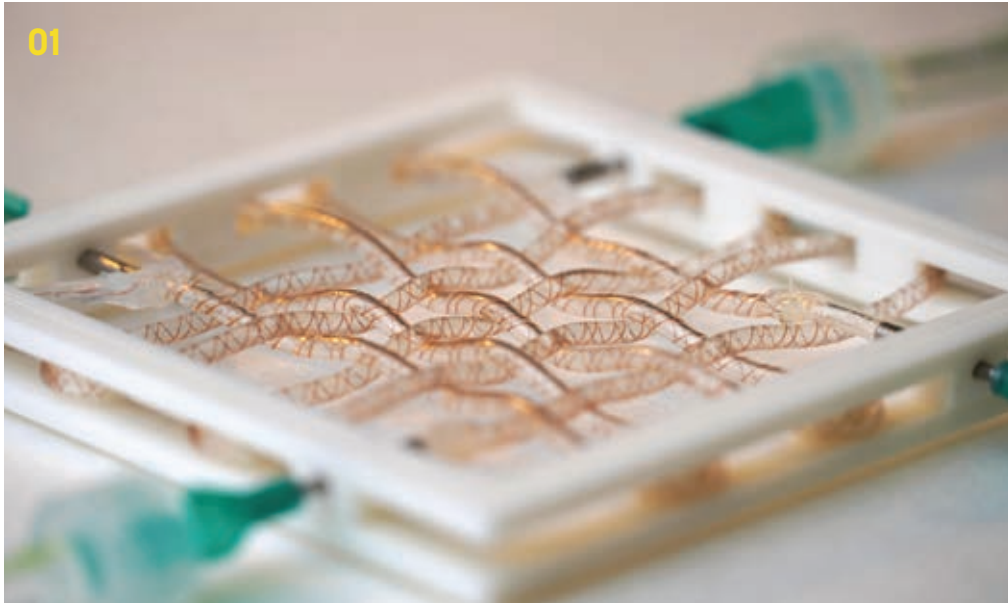
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**HYDROLOGY & WATER RESOURCES SYMPOSIUM 2023**  
**12-15 November 2023**

**Location:** in-person *Sydney*  
**Website:** [engineersaustralia.org.au/hwrs2023](http://engineersaustralia.org.au/hwrs2023)  
Innovation, collaboration and engineering excellence will come together for HWRS 2023 as it explores this year's theme of "Living with extremes". Topics will cover the spectrum of engineering hydrology – science to application – and the progress made in understanding the uncertainties facing water resources managers now and in coming decades.  
**Save the date**

THE LATEST DEVELOPMENTS FROM AROUND THE WORLD.





## 01 Thread pumps

*Fibre-like pumps, just 2 mm thick, can be woven into fabric and used in wearable devices. Image: © LMTS EPFL*

Swiss university EPFL has developed a thread-like pump that can be integrated into clothing, allowing wearable materials to incorporate high-pressure fluidic circuits. Although wearable technology is already able to include fluid-based devices, these have required large and impractical pumps to operate. EPFL's soft, fibre-like pump, however, uses charge injection electrohydrodynamics to permit flow without moving parts. "We present the world's first pump in the form of a fibre; in essence, tubing that generates its own pressure and flow rate," said Soft Transducers Laboratory head Herbert Shea. "Now, we can sew our fibre pumps directly into textiles and clothing, leaving conventional pumps behind." A palm-sized power supply can operate the pumps' helical electrodes, which ionise molecules of a non-conductive fluid, producing movement. The technology could find use in such applications as soft supportive exoskeletons, thermoregulatory clothing and immersive haptics.



## 02

### Energy-saving ink

*These inks can be added to phase-change materials to help save energy. Image: Dr Mohammad Taha*

**Research from the University of Melbourne focusing on inks that use nanoparticles could help develop materials that reduce energy consumption. The inks build on previous research into phase-change materials such as vanadium oxide, which block heat beyond a certain temperature. By bringing down the temperature at which this shift occurs – from 68°C to around 30 to 40°C – the inks help make the phase-change materials more practical to use. "These inks can adjust the amount of radiation that can pass through them, based on the surrounding environment, and could be used to develop coatings for buildings that enable passive heating and cooling – reducing our need to rely on energy creation to regulate environments," said Dr Mohammad Taha. "By engineering our inks to respond to their surroundings, we not only reduce energy expenditure, but negate the need for auxiliary control systems to adjust temperatures – these controls, like air conditioning or gas heating, are additional energy waste."**

## 03

### Centipede robot

*A greater number of legs allows this robot to negotiate rough terrain without sensors. Image: Georgia Tech*

A team at the US's Georgia Institute of Technology is creating multi-legged robots inspired by centipedes, which it hopes will be better equipped to negotiate uneven surfaces without extra sensors or control technology. The team theorised that adding redundant legs to the robot would allow it to move more reliably; if one leg falters as the bot moves along, another will be there to pick up the slack. "With an advanced bipedal robot, many sensors are typically required to control it in real time," said postdoctoral researcher Dr Baxi Chong. "But in applications such as search and rescue, exploring Mars, or even micro robots, there is a need to drive a robot with limited sensing. There are many reasons for such sensor-free initiatives. The sensors can be expensive and fragile, or the environments can change so fast that it doesn't allow enough sensor-controller response time." Having found that increasing the number of legs enhances the robot's movement, the team is now looking to determine the optimal number of legs.

## 04 Appetite stimulator

*An electroceutical capsule could help to stimulate appetite in some patients. Image: MIT*

An ingestible capsule developed at the Massachusetts Institute of Technology can act as an appetite stimulant, sending electrical signals to cells in the stomach that produce hormones. These hormones, such

as ghrelin, help to trigger feelings of hunger and reduce feelings of nausea. Although previous research had established that electrical stimulation could encourage the release of these hormones, creating the capsule required developing electrodes that were capable of making contact with stomach tissue. "This study helps establish electrical stimulation by ingestible electroceuticals as a mode

of triggering hormone release via the [gastrointestinal] tract," said Associate Professor Giovanni Traverso. "We anticipate that this could be used in other sites in the GI tract that we haven't explored here." If human trials are successful, the device could be used to treat conditions such as anorexia or cachexia, which causes chronic disease sufferers to lose body mass.

## ENGINEERS AT THE PINNACLE OF THE PROFESSION

**Kumbi Nzenza**

CPEng, Director  
CDSE Consulting

AS KUMBI NZENZA HAS RISEN UP IN THE WORLD OF CONSULTANCY HE'S FOUND IT IMPORTANT TO THINK AS AN ENTREPRENEUR AS WELL AS AN ENGINEER.

**03****TIPS FOR SUCCESS**

AS DIRECTOR of CDSE Consulting, Kumbi Nzenza finds his mind must travel two ways throughout the day: there is a business path as well as an engineering one.

"I'm responsible for the overall strategy of the business – the business development of new client relationships, engagements, and new projects," he told *create*.

"I [also] look after the construction management, project management, delivery arm of the business."

That has charged him with delivering some substantial projects, including Victoria's North East Link, on which he is currently working. But he said he has also found fulfilment in the smaller bespoke projects for which he has consulted.

This pride is reflected in Nzenza's enthusiasm for his work, and his appreciation for how he can balance engineering – "the fun bit," as he describes it – with his business responsibilities.

"Even as my career has progressed into more leadership roles and management roles, the technical is still very, very important; it adds another layer and an aspect that makes me a more well-rounded professional," he said.

"It gives me a different perspective from just being entrenched on projects or just working from a business point of view."

**1** There is so much you can learn by being open, listening and engaging.

**2** Know your own strengths and weaknesses.

**3** Without self-awareness, you will stagnate – and you will feel like you have a job rather than a career.



And straddling these roles means he can offer clients technical expertise, such as reviewing constructability, assessing engineering designs or determining how a project can be built cheaper and more efficiently.

But he acknowledges the challenges in uniting these mindsets.

"It does stretch you and it does require putting on different hats at different points in time," he said.

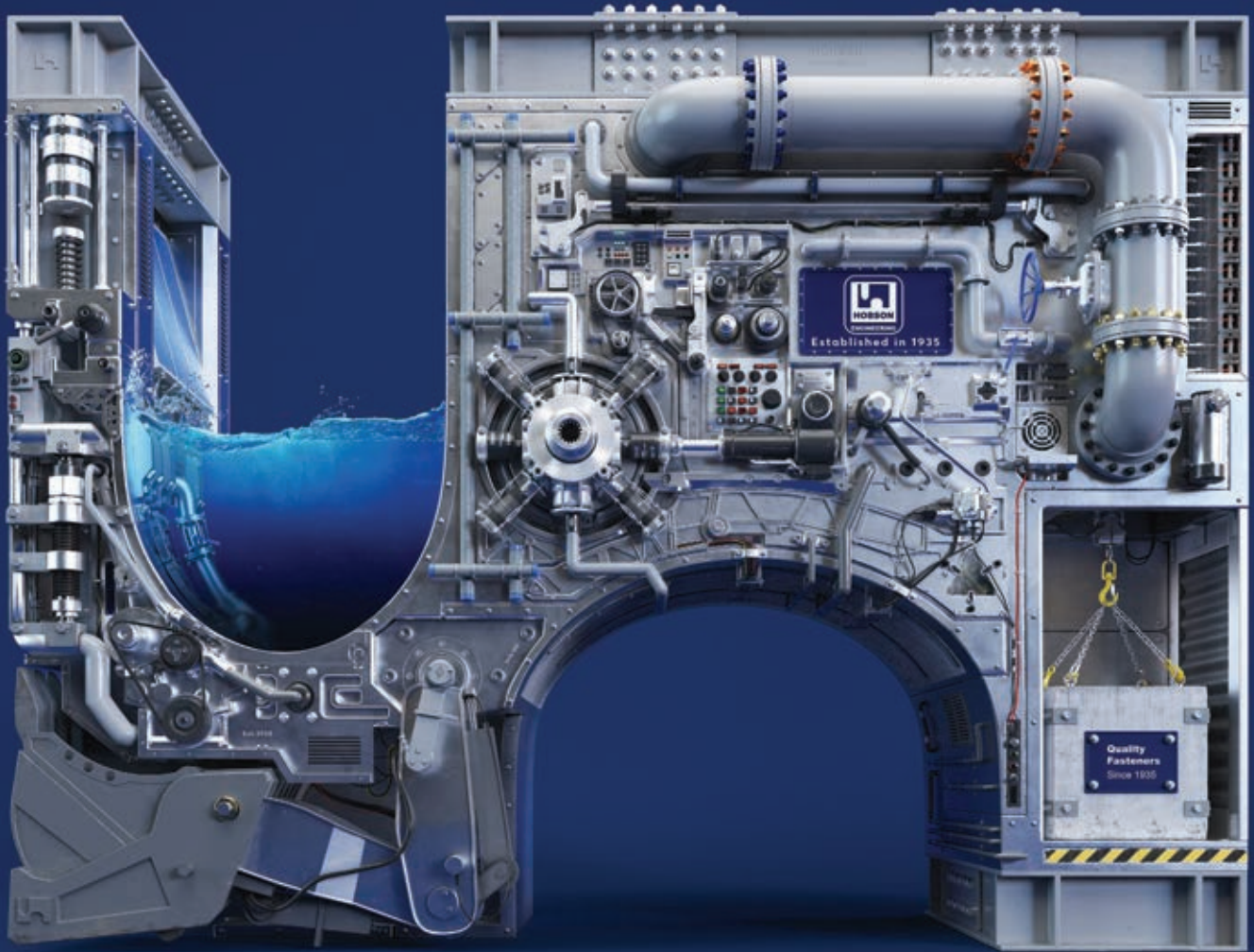
"If you've got that self-awareness, you can stay on top of it and you can excel, but if you try to do more than you're capable of or you don't lean on your partners in terms of people that work for you and people that work with you, you ultimately fail."

As CDSE Director, Nzenza has been an enthusiastic promoter of Chartership among the engineers he employs. His company has partnered with Engineers Australia to ensure every one of its engineers can become Chartered.

"From a company perspective, it was a no-brainer in terms of how we provide value to our clients and for them to see that the people that they're getting are Chartered, they're recognised by a professional body," he said.

"If you work for CDSE, we pay for and create the time for you to get your Chartership. That's us investing in our employees." ●

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