VOL. 9 | NO. 10 | NOVEMBER-DECEMBER 2023

create

ENGINEERS AUSTRALIA

ENGINEERING IDEAS INTO REALITY

A SUSTAINABLE MINDSET

HOW CLIMATE-SMART TECHNOLOGY WILL EMPOWER THE WORK OF ENGINEERS

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THE JOURNAL FOR ENGINEERS AUSTRALIA

VOL. 9 | NO. 10 | NOVEMBER-DECEMBER 2023

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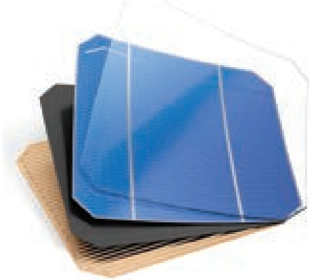

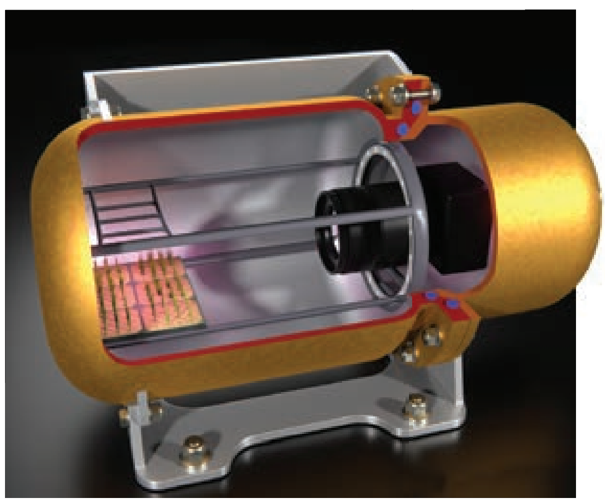

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NEWS

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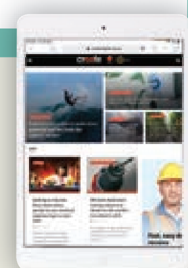

Sense and sustainability

ENGINEERS AUSTRALIA'S CLIMATE SMART ENGINEERING 2023 CONFERENCE POINTS THE WAY TOWARDS A GREENER FUTURE.

Welcome to the final issue of *create* magazine for 2023.

In this November–December edition, we celebrate our flagship Climate Smart Engineering Conference (CSE23) being held in person at the Melbourne Convention and Exhibition Centre on 29 and 30 November.

There is still time to register for this inspiring event, which connects climate thought leaders, innovators, engineers, policymakers, changemakers and industry to explore solutions to accelerate Australia's transition to net-zero emissions.

"One focus of the conference will be how climate-smart technology will empower the work of engineers as new climate challenges emerge."

One focus of the conference will be how climate-smart technology will empower the work of engineers as new climate challenges emerge.

The profession has a central role to play in the development of sustainable solutions and processes, and the contribution of engineering expertise and innovation is vital if we are to ensure a more resilient and sustainable world.

Sustainability solutions are a theme in this edition of ***create***.

Copenhagen's Amager waste-to-energy resource centre burns a lot of rubbish to produce energy for the surrounding community.

Now, Australia will replicate the technology with two plants to start operating in Western Australia next year and other states set to follow.

The engineers involved explain how this will unfold alongside waste-to-energy processes being one of the most stringently regulated technologies for energy production.

Australia has about 10 times the global installation rate of residential rooftop panels, but what happens when these panels reach end of life? Where does the solar waste go?

We hear from industry and researchers who have been working hard on answers and may be on the edge of a commercially viable way to recycle them.

A new development engineered on a former Melbourne landfill site is an example of the benefits of urban regeneration. The formally derelict New Epping site will be transformed into a residential and commercial precinct complete with the revitalisation of the site's creek and surrounding environment.

And can life exist on the moon? A group of scientists and engineers in Australia is creating a hyperbaric chamber to prove that growing plants in space can happen — and this will give us valuable insights into how seedlings adapt in challenging environments.

Those involved say this will help develop sustainability strategies for future plant life both here and in space.

Finally, our National Engineering Excellence Awards take place in Melbourne on November 29th. All nominees in their respective categories are so deserving of recognition for their incredible contributions.

We congratulate you all and wish you the very best.

See you in 2024.

Dr Nick Fleming
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Book tickets →

DEBATE AND DISCUSSION BY *CREATE* READERS

Slipping standards

The Committee of Australian Standard AS 4663 on slip resistance of pedestrian surfaces has recently been undergoing a review of this standard, which has been published since 2013.

Many Chartered engineers write expert reports for courts throughout Australia. Most, however, are not qualified tribologists, the field of expertise that applies to AS 4663, which is itself a tribological document. Thus, there are errors in AS 4663 that need redressing.

On highly profiled surfaces, the peaks or asperities are not covered in water when potable water is applied to its surface, so test results are obtained using, at best, a thin fluid film on top of the asperities.

"Most, however, are not qualified tribologists, the field of expertise that applies to AS 4663. Thus, there are errors that need redressing."

Thus, according to the Stribeck curve, the test result of the coefficient of friction will be lower and so in complete error. Most highly profiled surfaces cannot be tested unless you can prove a saturated film of water is present on top.

Likewise, on sloped surfaces, the water runs off — even at low angles of, say, three degrees — so here the surface is only covered in a fine film of fluid. Once again, Stribeck applies and the surface cannot be tested on the slope using any known instruments, pendulum or otherwise.

From *Makita v Sprowle*, omission of topographic analytical tests such as forensic tribology is an error, and one that can have serious consequences. Likewise, in the case of *Dasreef v Hawchar* there was a common theme from some experts of relying on speculation, such as offering slip resistance opinions without analysis based on tribology.

It is only a matter of time before either Victoria or New South Wales relies legally on that famous US case *Kumho Tire Co v Carmichael*, where an engineer was deemed, not being a tribologist, to not be an expert in tyres.

Conclusion: stick to your proven field of expertise, stay up to date, and note that it is unwise to stray outside it.

PATRICK DONOHUE CPENG
PRINCIPAL, OCCUPATIONAL FORENSICS PTY LIMITED

Need to know

On *create*'s article on data security ("Guard duty," October 2023), a good start for prevention would be to stop every online shop, council or club from demanding you open an online account with them with personal details.

Why, for example, does the public swimming pool need my birthday and telephone number when I purchase a bulk ticket? To call me for birthday wishes?

They cannot guarantee the safety of personal data yet demand it from customers to be able to use their services.

This needs to be stopped in the first place.

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create welcomes feedback from the community

Do you know of an exciting project we should write about? Is there an outstanding engineer in your midst? Are you working on an innovative technology that you'd like to share with your fellow members? Are there engineers out there doing their bit to help the community? Do you want to comment on an article you've read in *create*?

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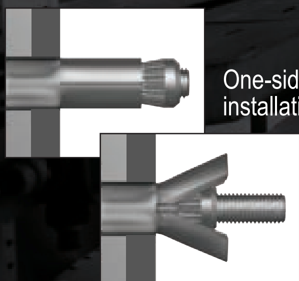

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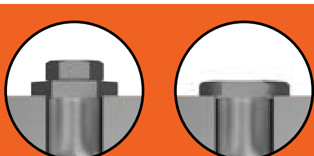

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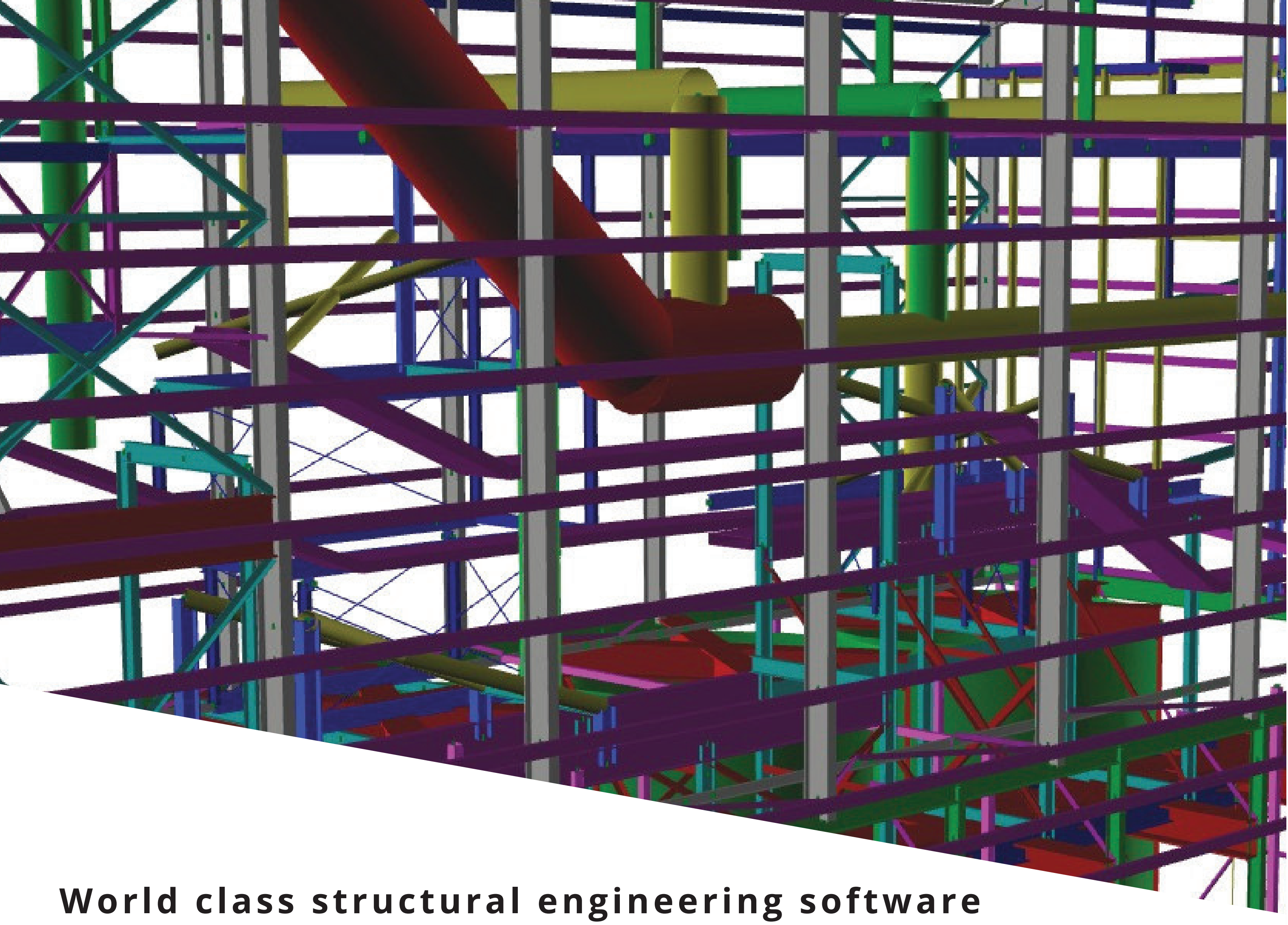

Choose your own adventure

NO TWO DAYS ON THE JOB ARE THE SAME FOR CIVIL ENGINEER JESSIE IRWANTO, WHO HAS BEEN CERTIFIED AS ENGINEERS AUSTRALIA'S 35,000TH CHARTERED ENGINEER.

JESSIE IRWANTO, Senior Structural Engineer at TTW, admits she gets to work on some "pretty cool" projects.

"I'm currently involved in the design of a hospital on the South Coast of New South Wales," she said.

"It's great to be involved in something tangible that helps people in the community, something that leaves an impression.

"It becomes part of your legacy – what you've worked on, what you've been a part of. That's the best part about structural engineering: to see something that you've worked on develop."

ABOVE: Jessie Irwanto, TTW, (left) and Engineers Australia CEO Romilly Madew.

Irwanto's career has taken her across the country and seen her work for a number of engineering consultancies.

She has now become the 35,000th engineer to receive the Engineers Australia Chartered credential.

"It's always rewarding to be recognised for your abilities and the integrity of the role you have," she told *create*.

"In our profession we're increasingly seeing that registration and Chartership is becoming more important – and with good reason. We're always being prompted to push the limits of our design and make things more efficient and cost-effective.

"Chartership really is something that everyone should be striving for and working towards so we can maintain standards and ensure that we're building things well."

At a ceremony marking the milestone, Engineers Australia CEO Romilly Madew said Chartership is a measure of excellence in the industry.

"Reaching Chartered status is a significant career milestone," she said.

"Engineers Australia is thrilled to celebrate Jessie's Chartered achievement and the fact she is our 35,000th Chartered engineer.

"Chartered credentials are internationally benchmarked and show a commitment to the highest professional standards. Becoming Chartered gives engineers a competitive career edge and means they have a globally recognised credential. It shows they have attained the highest standards of competency and commitment to their profession."

An engineering consultant's work is naturally varied and diverse; one job might be dominated by meetings with stakeholders, while the next might involve being out in the field from start to finish.

That variety is true too for Irwanto, who spoke to *create* from outside Luna Park on Sydney's harbourside, where she was conducting a site visit.

"CHARTERSHIP REALLY IS SOMETHING THAT EVERYONE SHOULD BE STRIVING FOR AND WORKING TOWARDS SO WE CAN MAINTAIN STANDARDS AND ENSURE THAT WE'RE BUILDING THINGS WELL."


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PICTURED: Irwanto conducting a site visit.

"At a concept phase, I spend a lot of time in meetings with architects and clients, deciding on deliverables and deadlines critical to the project," she said.

"During design, I spend a lot of time doing analysis and working with the construction team, and solving problems that have come up onsite.

"I've always wanted to diversify my experience and work on many kinds of buildings. Consulting can take you anywhere. You can choose your own adventure, which is fun."

She describes a decision she made at university to shift focus from chemical to civil engineering.

"It was the appeal of doing something that was so broad, that could take me into a lot of different industries," she said.

"As a young kid not knowing what to do, that seemed like the best option."

Irwanto has since worked at multiple other consultancies.

"I started out as a grad at what was then SKM and is now Jacobs Engineering, and worked on infrastructure projects in water, power and mining," she said. "So a lot of tangible structural work, but in very different industries. I then decided I wanted to work on commercial high-rise buildings, so I moved to WSP, where I got to work on some awesome commercial and apartment buildings in Perth.

"It was very cool to see the skyline shift and change the way people interact with the city."

Irwanto said that, given the nature of consulting, she isn't sure what her next big project will be, but is confident it will materialise in time.

For now, she is looking forward to seeing the hospital she is currently working on be finished.

"That's the fun thing about engineering and consulting: getting to see projects you're a part of come to life."

LACHLAN HAYCOCK

04 TIPS FOR SUCCESS

1. There's no such thing as a dumb question.
2. Listen and learn from as many people as you can.
3. Look at the bigger picture.
4. Work towards things that you find interesting.

"I'VE ALWAYS WANTED TO DIVERSIFY MY EXPERIENCE AND WORK ON MANY KINDS OF BUILDINGS. CONSULTING CAN TAKE YOU ANYWHERE."

SETTING SUN

WORDS BY **JAMIE SEIDEL**

AUSTRALIA MUST SOON CONFRONT HUNDREDS OF THOUSANDS OF TONNES OF SOLAR WASTE WITH NOWHERE TO GO. WHAT HAPPENS WHEN ESSENTIAL NATIONAL INFRASTRUCTURE BECOMES A CONSUMER COMMODITY?

ABOVE: Associate Professor Penelope Crossley.

AUSTRALIA LEADS the world in the adoption of solar energy. The installation rate of residential rooftop panels is ten times the global average.

Since the 1990s, more than 3.3 million homes have had photovoltaic (PV) systems fitted. That equates to more than 80 million panels.

Good intentions are driving this investment.

"Photovoltaic is the most popular renewable energy source," said Deakin University materials researcher Dr Md Mokhlesur Rahman. "The reasons are simple. It can produce very clean electricity. It can produce low-cost electricity. And, once installed, there is no maintenance cost."

But PV cells also present a paradox. They're disposable, like computers, televisions and mobile phones – but on a far larger scale.

And that's put Australia at the forefront of a new solar e-waste problem.

"Electricity generation has gone from an industrial model to a general public model," John Polhill, Sustainability Victoria manager of infrastructure partnerships, told *create*.

"In doing so, the nature of the generator has changed. It's now a consumable."

The International Renewable Energy Agency estimates that Australia will have to contend with 450,000 t of used panels by 2040.

The first wave is already upon us, with "early adopters" discovering their units are reaching the end of their advertised 25-year lives.

Adding to the problem are panels damaged in transit, installation and extreme weather.

According to the University of Sydney, up to 90 per cent of these are currently being smashed and dumped as toxic landfill.

"National solar recycling has been listed as a key environmental priority for the Australian government for the past seven years," said Associate Professor Penelope Crossley of the Sydney Law School.

"However, there is still no national legal framework to address the end of life of solar panels."

But, behind the scenes, Australian industry and researchers have been chipping away at the problem. And they think they're on the brink of finding a commercially viable means of recycling them.

"The photovoltaic cell was created here in Australia by one of our partners, the University of New South Wales," said Richard Petterson, CEO of Adelaide-based panel manufacturer Tindo Solar.

"They couldn't attract the right sort of investment, so they went overseas. Hopefully, we can do better this time around."

A FULL LIFE

On average, a good-quality solar panel will lose about half a per cent of its productivity each year.

The generally accepted threshold for replacement is 80 per cent, which should happen about 25 to 30 years after installation.

While a solar panel's protective tempered glass can get scratched or decolourised, the leading cause is the constant cycle of heat and cold, along with the buffeting of wind that gradually delaminates the layered components within the PV cell itself.

Solar panels are designed to be incredibly robust, said Anthony Vippond, co-founder of e-waste recycler Lotus Energy.

"They have to survive tough conditions, and that's because they have high-voltage DC running through them while sitting on top of somebody's house," he explained. "Then, when you take them off the roof, everybody complains that they're so difficult to break down. The reality is that's a necessary evil of the product."

But panels are coming off roofs faster than anticipated. Some are recording lifespans as low as seven to 10 years.

It's partly a consequence of a consumer mentality, said Petterson.

"When people buy a house and decide to renovate, that often includes updating the solar system," he said.

"NATIONAL SOLAR RECYCLING HAS BEEN LISTED AS A KEY ENVIRONMENTAL PRIORITY FOR THE AUSTRALIAN GOVERNMENT FOR THE PAST SEVEN YEARS. HOWEVER, THERE IS STILL NO NATIONAL LEGAL FRAMEWORK TO ADDRESS THE END OF LIFE OF SOLAR PANELS."

LEFT: Richard Petterson (right), Tindo Solar.

"Or they don't want mismatched panels if they want to expand."

Then there are those who re-roof.

"The current regulations around solar panels mean that once they come off, we can't put them back on. So that's potentially another reason why lifespans are lower than expected," Petterson added.

"But the biggest underlying cause is just poor manufacturing and poor handling leading to early delamination."

RECYCLING CHALLENGE

The Australian Renewable Energy Agency (ARENA) puts the cost of recycling a solar panel at $29. That's six times as much as sending it to landfill.

Extracting enough value to overcome this difference is not a problem unique to solar recycling. But PV cells are particularly resilient.

The inverter, cabling and structural frames are all fed into existing recycling schemes.

What's left over is mostly glass that contains film-like minerals coated – doped – with toxic materials to improve their efficiency.

"The PV panel is only five per cent highly valuable silicon," said Rahman. "Maybe 75 per cent is tempered glass, 10 per cent polymer – encapsulant and back sheet foil – eight per cent aluminium and about two per cent are other elements – cadmium, lead, chromium, selenium, boron, silicon nitride."

In landfill, those heavy metals could mix with soil and water.

"And that means it can contaminate groundwater, which poses health risks to humans and wildlife," Rahman said.

Polhill said the difficulty of extracting silicon and glass of sufficient quality means most panels end up crushed or stockpiled.

"People have in the past said, 'We recycle solar panels.' But when you delve a little bit further, they just take the frame off," he said.

"That's not recycling. That's just stripping off the valuable piece and landfilling the rest."

ABOVE (from left): Akhil Nelson, Dr Md Mokhlesur Rahman and Professor Ian Chen, Deakin University.

"THEY JUST TAKE THE FRAME OFF. THAT'S NOT RECYCLING. THAT'S JUST STRIPPING OFF THE VALUABLE PIECE AND LANDFILLING THE REST."

Value-adding scrap

Until recently, no successful end-of-life photovoltaic (PV) cell reprocessing system had been found.

But Deakin University's Dr Md Mokhlesur Rahman told *create* he is in the midst of talks to commercialise his new technique, so, he's unable to share intimate details about the technology.

But he said the solution lies in keeping the recycling process pure.

"Most of the recycling industry around the world just crushes everything," he said. "When they crush a PV cell's tempered glass, often its only real use is as a building material."

New technology is needed to recover silicon wafers from a panel without cross-contamination. Further high-yield purification is needed to reprocess the silicon as nano silicon.

"Keeping the panel intact massively reduces the recycling cost," Rahman said. "And our deconstruction process is very successful at separating all the materials without any cross-contamination."

Ethylene-vinyl acetate and back sheets can go to the polymer industry. Clear tempered glass can be reused. Many elements return to circulation.

"Each and every material in a PV cell has the potential to be reused and contribute to the economy," he said. "So our job is to recover elements from these PV wastes and turn them into high-volume, high-value materials."

But the greatest value can be found in pure silicon.

"We have developed an environmentally friendly, low-cost purification process. It can remove all kinds of heavy metal and other elements from a silicon PV cell and purify it up to 99.3 per cent."

This is sufficient quality for producing the silicon-graphite materials for lithium-ion battery anodes. It can also be milled into nanosilicon.

"This is one of the key elements in battery manufacture — particularly for electric vehicles, but also cell phones," said Lotus Energy's Anthony Vippond.

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The West Gate Bridge Project

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

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

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

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

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

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

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

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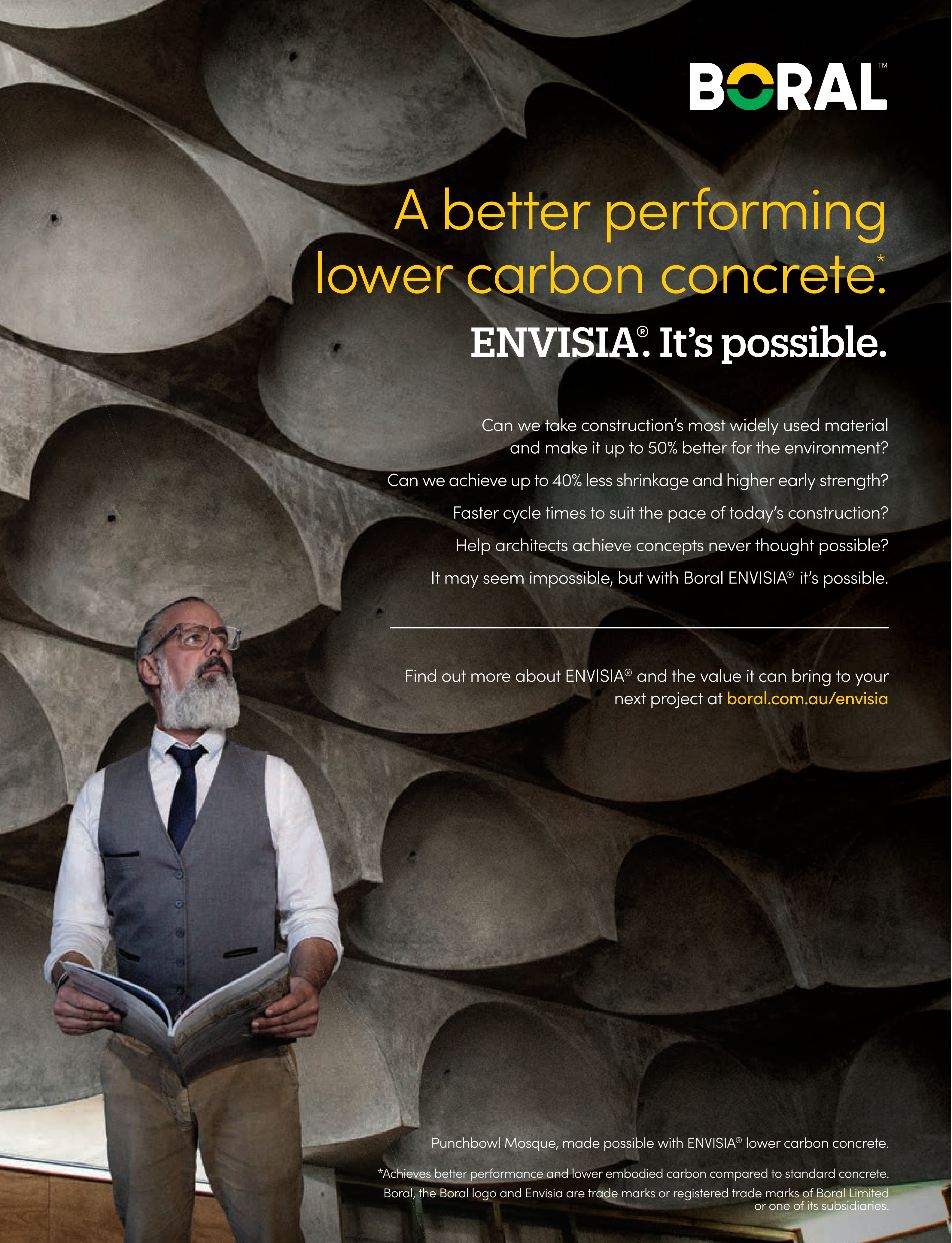
FINISH: A final topcoat of Weathermax® HBR MIO ensured a high build finish.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But overcoming the resilience of PV cells takes effort and energy.

"There is pyrolysis or thermal treatment, but that puts carbon in the glass and devalues it," Polhill said. "It can be crushed and screened as a sand additive. I know there are trials using it in pavement. But that's a value-loss situation. It's downcycling."

Rahman, with Professor Ying (Ian) Chen at Deakin University, is exploring new technologies to separate the cells, purify the material, and turn them into high-value nano silicon. But none are yet commercial.

"We're at that tipping point where whoever brings to market something viable in the next two to four years will certainly become a market leader," Polhill said.

Repurposing cells is a technical, legal and legislative challenge. They are, after all, powerful electronic devices.

And Polhill said re-use schemes can be abused as a means of exporting the waste problem.

"They shouldn't be sent offshore," he said. "But it's a perfect opportunity to decentralise power for remote and low socio-economic communities."

Space isn't a problem in the outback, he adds, meaning a need for more panels to reach the same output isn't a significant concern.

Meanwhile, the Australian government is preparing to legislate a product "stewardship" scheme to pay for solar waste collection, similar to those for computers and televisions.

ABOVE: John Polhill, Sustainability Victoria.

"WE'VE MADE THE EFFORT TO GET ALL THOSE MINERALS OUT OF THE GROUND AND TURN THEM INTO USABLE ELEMENTS. SO THE BEST OUTCOME IS TO GET THE MAXIMUM POSSIBLE USE OUT OF IT."

SUSTAINABLE SOLUTIONS

Engineered resilience is a PV cell's greatest asset, as well as its greatest curse. But it may also be part of the solution.

"The great thing about solar panels is they're pretty inert," said Polhill. "They store and stack nicely and do not need to be undercover. And when dismantled, risk of fire in stockpiled material would be low."

That means the material can be amassed both in anticipation of better recycling technology and to reach a commercially viable scale.

But while a consumer might find a fall to 80 per cent of original output unacceptable, that PV cell remains perfectly functional, with probably another decade or two of useful life left in it.

"We've made the effort to get all those minerals out of the ground and turn them into usable elements, and that's where most of the carbon investment is," Petterson said. "So the best outcome is to get the maximum possible use out of it."

"You've used the system. That system is now no longer adequate, so you're buying a new one," Polhill said.

"And then you're asked to pay to dispose of the waste as well. That's not in our consumer instincts.

"But if you internalise the cost in the purchase price, that money is already in the system for when that product reaches end of life." ●

ABOVE (from top): A Lotus Energy recycling plant; Lotus Energy CEO Anthony Vippond.

Making ends meet

The sheer scale of the looming photovoltaic cell problem is daunting, said Lotus Energy CEO Anthony Vippond.

"From the recycling point of view, it is a crazy, incredible challenge."

In preparation, his Melbourne-based e-waste recycling business is looking to invest in new and improved technologies to tackle the problem.

"We're not getting the highest possible value out of it yet. It's not perfection," Vippond told *create*.

"But I use the analogy of Henry Ford: If we waited for perfection, we'd never build it."

He said about 97 per cent of a solar panel is currently being recovered.

"There are efficiencies we can improve within that 97 per cent, such as purer glass. The remaining three per cent is mainly the backing sheet substrate and the plastic cable sheet in the junction box."

He's hoping solutions to both are just around the corner.

"We've done trials with Deakin University and Dr [Md Mokhlesur] Rahman for separating the solar panel to extract the silicon cells. We've also done trials with industrial microwaves to get at that remaining 3 per cent of plastic," he added.

But the biggest challenge remains the valuable rare earths and critical minerals.

"Eddy current and electrostatic machines are brilliant," he said. "But they're not able to pick out something at the scale of nanometres."

Finally, there's the matter of balancing the environmental books.

"We've done a bit of analysis on this," said Vippond. "Typically, a solar panel will pay for itself in terms of its manufacturing within two or three years. And the carbon footprint of new recycling technologies appears to only add about six months to that."

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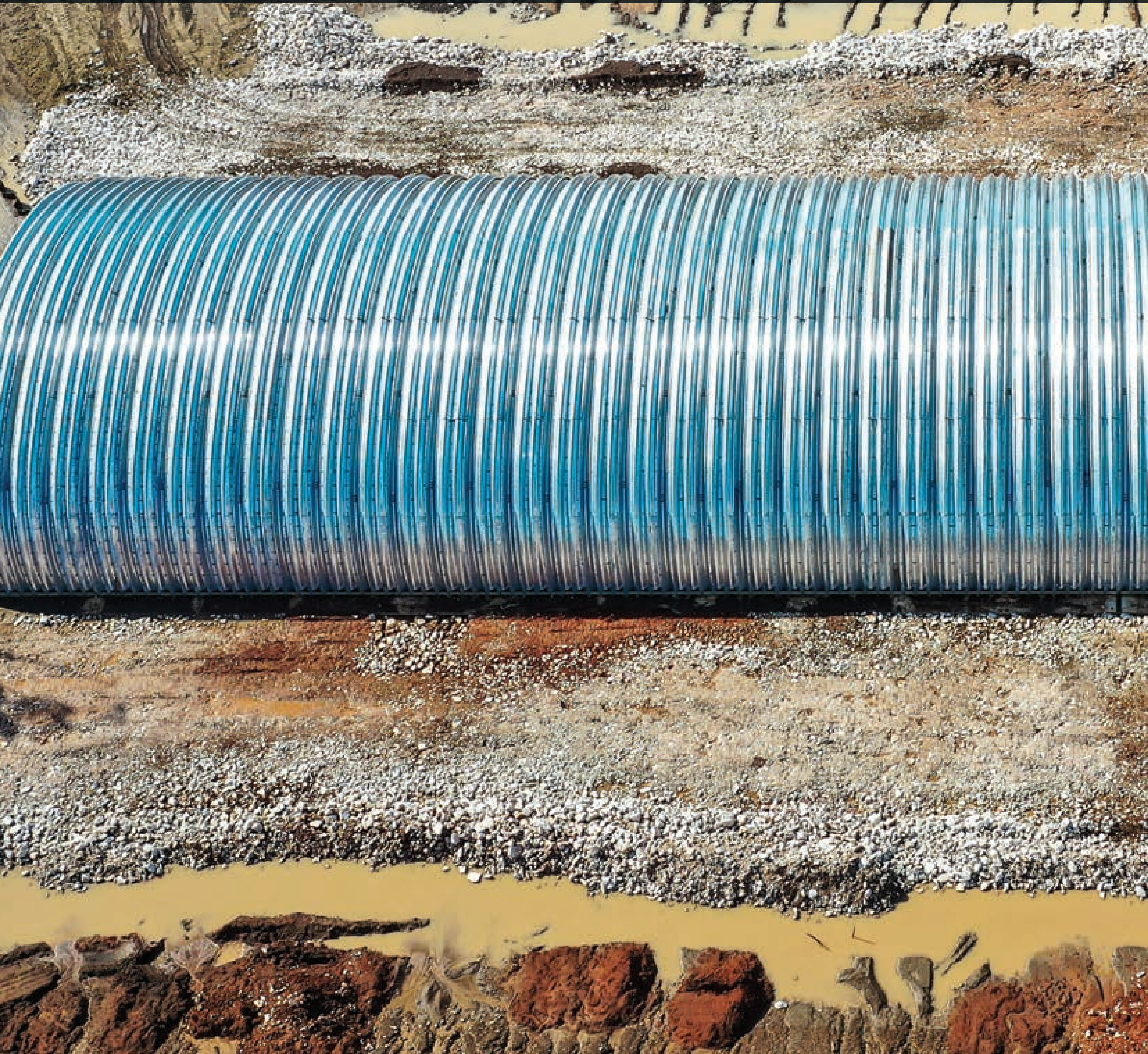


WORDS BY **CHRIS SHEEDY**

WORKING ON A BETTER TOMORROW

NOW IN ITS THIRD YEAR, ENGINEERS AUSTRALIA'S CLIMATE SMART ENGINEERING CONFERENCE WILL FOCUS ON HOW CLIMATE-SMART TECHNOLOGY WILL EMPOWER THE WORK OF ENGINEERS.

WITH THE global environmental focus on climate – a focus that will only increase over the next several decades – new and fascinating engineering challenges arise on a daily basis.

Engineers have a leading role to play in the development of sustainable solutions and processes, and technology will assist in the creation and execution of those solutions.

"The battle to combat climate change has well and truly entered its engineering phase," said

Engineers Australia CEO Romilly Madew. "The profession's expertise, innovation and dedication are central to ensuring a more resilient and sustainable world."

At the 2023 Climate Smart Engineering conference (CSE23), many engineering thought leaders and innovators will come together to share powerful insights into how climate-smart technology will enable and accelerate the work of engineers, Madew said.

"The engineering profession is deeply invested in advancing renewable energy technologies, such as wind turbines, hydro, batteries and solar," she said.

"Many are exploring methods such as green hydrogen to power our future.

JUST UNDER

73%

of all global greenhouse gas emissions come from the use of oil, coal and gas – primarily for energy.

RIGHT: Romilly Madew, CEO, Engineers Australia.

"THE BATTLE TO COMBAT CLIMATE CHANGE HAS WELL AND TRULY ENTERED ITS ENGINEERING PHASE."

"Climate change isn't a singular issue. Engineers are tackling multifaceted problems, from rising global temperatures to unpredictable weather patterns."

Climate-smart technology will play a central role in every engineering solution. But what exactly is it?

SAVING THE WORLD

Many people believe digital technology will save the world, said Dr Alan Finkel, neuroscientist, engineer, entrepreneur and philanthropist. But without physical technology, the climate crisis will never be addressed.

"Around 99 per cent of climate-smart technology is hardcore, physical technology rather than digital technology," said Finkel, Chair of Stile Education, a corporate adviser on climate change technologies and author of the recently released book *Powering Up: Unleashing the clean energy supply chain.*

"It will use digital technology for operational optimisation. But what's important is the electricity that allows you to run your smartphone and your cloud-based computer data centre."

"That's an important distinction, because so many people think the future of the world is digital technology. They forget that the digital technology needs rare-earth elements to make the glass screens of their smartphones and electricity to keep their homes running."

What will make this technology climate smart, Finkel said, is emissions elimination.

"If you look at the contributions to emissions, just under 73 per cent of all global greenhouse gas emissions come from the use of oil, coal and gas – primarily for energy," he said. "So, if we can wean ourselves off oil, coal and gas and replace the energy that they deliver with zero-emission sources, then we will have put a huge dint in emissions."

Climate-smart technology then, Finkel said, is essentially technology that enables the replacement of oil, coal and gas with renewables.

Change from conventional fruit and vegetables to organic fruit and vegetables and you're doing close to nothing for the future of the planet, he said.

But put solar panels on your house or business and you've become a part of the solution.

At CSE23, Finkel will be discussing the practical pathway to achieving the replacement of coal, oil and gas in Australia, including the essential role of green hydrogen and the specific challenges for engineers along the way.

"SO MANY PEOPLE THINK THE FUTURE OF THE WORLD IS DIGITAL TECHNOLOGY. THEY FORGET THAT THE DIGITAL TECHNOLOGY NEEDS RARE-EARTH ELEMENTS."

RIGHT: Dr Alan Finkel, Stile Education.

BEYOND CUTS

Cutting carbon emissions isn't all that climate-smart technology will be about, said Lisa McLean, CEO of Circular Australia.

If emissions reduction is the only focus, we'll still have a linear economy, with everything designed to be thrown away.

"That is totally unsustainable," she said.

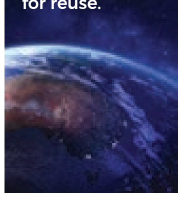
"Ninety per cent of materials are either wasted, lost or remain unavailable for reuse. We don't get value out of them.

"More than half the materials currently going to landfill here are our biggest economic opportunity for recycling – organics, masonry and plastics.

"Today there is more gold and silver in a tonne of iPhones than a tonne of ore from a gold or silver mine, and we have more things on the planet, more objects and products, than we do natural capital. We can't continue to use resources like this, especially with 90 per cent redundancy in the things we already make."

90%

of materials are either wasted, lost or remain unavailable for reuse.



Another challenge then, for engineers involved in design, production, materials and more, is to focus on technology that will enable the constant reuse and recycling of every component.

"The economic model we have now, the one we've had since the Industrial Revolution, is at the end of its life," said McLean, who is speaking at CSE23 on the circular economy.

"A circular economy is the only economic framework we have to grow jobs and industries in a resource and carbon-constrained future."

The technology beginning to appear around this concept is truly exciting, she said.

It supports designing out waste and pollution, retaining materials in the economy, upcycling components to ensure they remain at their highest value, and regenerating natural systems.

And it's not just about products; it's also about systems.

Consider the infrastructure transporting water in a linear fashion from dams through households, only to be flushed out to sea – and, with it, essential nutrients like phosphate, she said.

The water and nutrients in it should be retained to support biodiversity and environmental flows to drive productivity: through nutrient reuse for fertiliser for example.

Once that is achieved, that infrastructure becomes a part of the climate-smart technology solution.

"TODAY THERE IS MORE GOLD AND SILVER IN A TONNE OF IPHONES THAN A TONNE OF ORE FROM A GOLD OR SILVER MINE."

BELOW (from left): Lisa McLean, Circular Australia; Jared Crossley, AECOM.

DATA AND DECISIONS

Jared Crossley, Principal Civil Engineer at AECOM, is primarily office-based. He manages designs but doesn't often witness the construction of those designs.

That opens him up to new ways of doing those things.

"There are a lot of things I often realise are not particularly efficient, and I wonder whether there's a better way," said Crossley, who at CSE23 will be presenting a case study on the Hawkesbury-Nepean Valley Flood Evacuation Road Resilience Program, a project focused on road performance when people need it most.

"Is there a way we can automate or make very menial tasks more consistent and efficient, so we can focus our energy on more important stuff?

"Every bit of work we do uses electricity and company resources and grows our carbon footprint. If we can find a way in our systems to automate things and use new tools and software to do more in less time, that's ultimately more efficient and, from an environmental perspective, more sustainable."

Crossley defines climate-smart technology as the technology we embrace as engineers, whether related to materials or systems, that helps us do more with less – less resources, materials, time and effort.

"Engineering for future generations is about thinking about how we can embrace newer, greener technologies," he said.

"It's about freeing ourselves of small issues to have more time to think about how we solve the climate problem."

Some of that technology, and the driver behind much of the best decision-making for engineering design and materials choices, will come from the digital realm.

McGregor Coxall, a multi-disciplinary landscape architecture, urbanism and environment firm, has developed Biourbanism, a city planning and urban design platform that assists leaders and planners to create healthier, more resilient cities.

"We're looking at how do we bring together data such as geospatial data and human-centred data to provide a lens that looks through multiple systems and understands how those systems connect together," said Dr Robyn Mansfield, Associate Director at McGregor Coxall. "It's an interdisciplinary model that is inherently difficult to put together in a way that helps you understand the implications of looking through multiple lenses.

"We can build these decision-making tools from scratch to really understand not only how these things are interconnected, but also what are the implications of any action that you want to take."

At CSE23, Mansfield will discuss how multiple data pools, such as water and socio-economic data, bushfire and flood modelling, heat mapping and liveability indicators, can be integrated to enable analysis of specific issues or to highlight particular problems and find new solutions.

"You can then develop scenario models," she said.

"If we make this intervention in this particular area, what will then happen further down the track? Are we introducing new hazards as a result of that? Or is this going to have a flow-on effect into other systems that are actually going to improve the system?"

Such a base of data-driven, multi-disciplinary evidence also serves as a powerful tool to break through the political layer, Mansfield said. That's the layer that is all about clear and relevant communication, the one that gifts a project the backing of the entire community when it is done well.

A HUMAN CHALLENGE

Engineering and communication are increasingly intertwined. One cannot work without the other.

Stakeholders must understand and support a project if it is to be a success. Their local knowledge and the hopes and dreams they have for the ways they might use the new infrastructure or systems ultimately inform the best design.

With this in mind, Jane MacMaster, Chief Engineer of Engineers Australia, will be hosting a panel at CSE23 about how engineers can communicate the value of engineering for greater impact and influence in the context of climate change.

> **"HOW DO WE BRING TOGETHER GEOSPATIAL DATA AND HUMAN-CENTRED DATA TO PROVIDE A LENS THAT LOOKS THROUGH MULTIPLE SYSTEMS."**

BELOW: Dr Robyn Mansfield, McGregor Coxall.

LEFT: Jane MacMaster, Engineers Australia.

Smart choices

According to Engineers Australia Chief Engineer Jane MacMaster, one of the many positive outcomes of effective communication with all stakeholders is better and faster decision-making.

And it's only with better and faster decision-making that climate-smart technology will be identified and implemented on engineering projects.

"In the context of what we'll be discussing at CSE23, sustainability means ensuring future generations are at no disadvantage compared to those that came before," she said.

"That can only be achieved through a decrease in emissions and a decrease in the use of virgin materials. It's a decrease in environmental impact, a positive social impact and improved resilience."

"Engineers are good at talking to other engineers in technical language and in terms of engineering concepts," MacMaster said.

"As a generalisation, our profession is not great at talking about engineering and its outcomes in economic terms or societal terms.

"That resonates with policy-makers and decision-makers, and this can be a disservice to our profession in that the technical perspective is not always representative sufficiently as it should be in those very strategic conversations."

Engineering as a profession is all about serving the community and serving people, MacMaster said.

"I actually like to extend that a bit and say we're here for people and planet," she said.

"We want to reduce the environmental impact ... but it's also about making life better for people.

"That is a fundamental part of engineering. We're not here for any other purpose than to make life better. And we're shooting ourselves in the foot if we try to do it by using high-emissions technology." ●

"WE'RE NOT HERE FOR ANY OTHER PURPOSE THAN TO MAKE LIFE BETTER. AND WE'RE SHOOTING OURSELVES IN THE FOOT IF WE TRY TO DO IT BY USING HIGH-EMISSIONS TECHNOLOGY."

CLIMATE SMART ENGINEERING 2023

Take a deep dive into climate smart infrastructure at Climate Smart Engineering 2023. Now in its third year, the conference will explore the latest in world-leading views and engaging debate on solutions to address climate change, responding to extreme events, biodiversity loss, boosting the circular economy and upholding the principles of sustainable practices in engineering.

When: 29–30 November 2023
Where: 1 Convention Centre Place, Melbourne
Website: *engineersaustralia.org.au/cse*

WORDS BY **JONATHAN BRADLEY**

HOT GARBAGE

COULD PRODUCING POWER FROM INCINERATED GARBAGE BE GOOD FOR THE ENVIRONMENT? THE ENGINEERS INVOLVED EXPLAIN WHY AUSTRALIA IS ADOPTING WASTE-TO-ENERGY TECHNOLOGY.

ABOVE: Richard Kirkman, Veolia. BELOW: The Kwinana energy facility, Perth.

THE CITY of Copenhagen is a picturesque metropolis that spreads over a series of natural and artificial islands along Øresund strait. Residents enjoy a high quality of life, in an easily navigable urban environment recognised globally for its environmental sustainability.

One local attraction enjoyed by residents of this bustling Scandinavian burg is the Amager Resource Centre (ARC), a facility in the neighbourhood of Amager East where residents can ski down a grassy slope, enjoy public gardens and make use of a climbing wall.

But ARC's principal reason for existence has nothing to do with recreation. The primary responsibility of this facility, nestled in the Danish suburbs, is burning garbage.

Lots of it in fact. In 2022, the Amager Bakke plant took in 533,000 t of waste, which

it incinerated on site to produce energy for the surrounding community.

These waste-to-energy facilities are not unique to Denmark. They're well-established components of the circular economy infrastructure in a range of countries around the world, from Sweden to Spain, the UK to Japan.

Now, after years of hesitancy and regulatory groundwork, the technology is coming to Australia; two plants are to begin operation in Western Australia next year, with other states to follow.

One of these, Avertas Energy in Kwinana, will power up to 55,000 Perth homes. Danish consultancy Ramboll is the owner's engineer, while operation and maintenance will be managed by waste disposal environmental services company Veolia.

Luke Holt FIEAust, a mechanical engineer and Ramboll Waste to Energy and Carbon Capture Head of Department in Asia Pacific, told *create* that one reason waste-to-energy facilities like this one actually help to reduce greenhouse gas emissions is that the alternative – landfill – produces methane, a far more climate-intensive gas.

"In landfill, we have an anaerobic chemical reaction taking place," he said.

"Once it's covered there's no access to oxygen, so what we see is that carbon material breaks down into methane – CH_4 – which is 20 to 30 times worse for the environment than carbon dioxide."

ALTERNATIVES TO LANDFILL

It is an unusual circumstance where emitting carbon dioxide is the better option for the environment. But Holt is clear-eyed about the limitations of the technology. Waste-to-energy is a circular economy solution that works in tandem with other approaches.

"Let's not fool ourselves: the amount of waste we generate is more than we probably should be generating and could be further reduced," he said. "It's a better alternative than landfill [but] the waste hierarchy clearly indicates that we're better off to minimise our waste and recycle it, before we even consider putting it through an incineration facility or something that recovers the energy from the waste."

Waste-to-energy, then, is a backstop that delivers the cleanest and most efficient solution for garbage that cannot be recycled with current technology.

"We really only should be incinerating or burning waste which has had all of the recyclable material picked out of it and has had all of the food organics or garden organics taken out of it to be used in a more appropriate manner," Holt said.

Although the Kwinana plant, was the first to begin construction in Australia, it's another nearby facility in East Rockingham, also to be operated by Veolia, that will be the first open.

Veolia Australia and New Zealand CEO Richard Kirkman told *create* that waste-to-energy is the solution for when alternatives aren't suitable.

"We're always trying to increase how much we can recycle and compost, but we know that there's a finite limit to that," he said. "Then we have two choices, which are landfill or recovering the energy from that material."

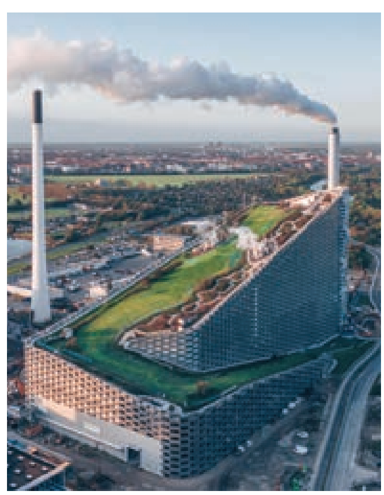
And it is the ability for waste-to-energy to complement other sources of renewable energy that Kirkman sees as its big strength.

"When it comes to this transformation from fossil fuels to renewables, it's important to have a range of solutions and not just have one big solution," he said. "If you just have solar, there's the 'duck curve' of solar production, where you don't get any production during the night. You can settle that somewhat with storage – with batteries – but having rotating machinery that provides electricity – steam

BELOW: Amager Resource Centre (left) received a visit from Engineers Australia CEO Romilly Madew and National President Dr Nick Fleming earlier this year.

"WE REALLY ONLY SHOULD BE INCINERATING OR BURNING GARBAGE WHICH HAS HAD ALL OF THE RECYCLABLE MATERIAL PICKED OUT OF IT."

ABOVE: Luke Holt, Ramboll.



turbines – provides strong resilience.”

He predicts that the entirety of Australia’s residual waste biomass could produce about 10 per cent of the country’s energy supply. But, at this stage, his ambitions are modest.

“Realistically, we’ll be able to produce one to three per cent through these technologies – anaerobic digestion and energy-from-waste – but that’s a significant amount, because otherwise we won’t have enough energy,” he said. “It’s important to have that resilience and that flexibility in that range of solutions to provide a really robust system.”

WASTE, NOT COAL

When it comes to operating a waste-to-energy facility, Kirkman said, the plants have some similarities to traditional coal-fired power stations.

“In a coal-fired power station, you burn the coal, and then use the heat energy that’s released to boil water, that water turns to steam, and then you run a steam turbine to produce electricity,” he said. “We’re using waste – and three tonnes of waste equals about one tonne of coal. The difference is that we thermally treat the waste under highly controlled conditions, and the heat energy that’s released from that waste is used to boil water.

“That water produces steam; we run a steam turbine, and we produce electricity. We also spend a lot of the investment money – probably about one-third of the investment in a facility – on cleaning the flue gases to a very, very clean level.”

But the process is not as simple as might be imagined.

“What’s in your bin and what’s in my bin are going to be very different, and are going to behave differently when you put them through the facility,” Holt said. “So there are a lot of fluctuations and a lot of variability that needs to be considered, and so, facilities need to be designed in such a way that they can be quite resilient and handle that fluctuation in the waste profile.”

TRACKING EMISSIONS

Kirkman described waste-to-energy processes as “one of the most stringently regulated technologies around the world for energy production”.

“When that carbon dioxide is released, it’s what we call short-term carbon dioxide: It’s recently been grown, recently been released, so it’s carbon neutral. And that provides energy which is more renewable than fossil-based energy,” he said.

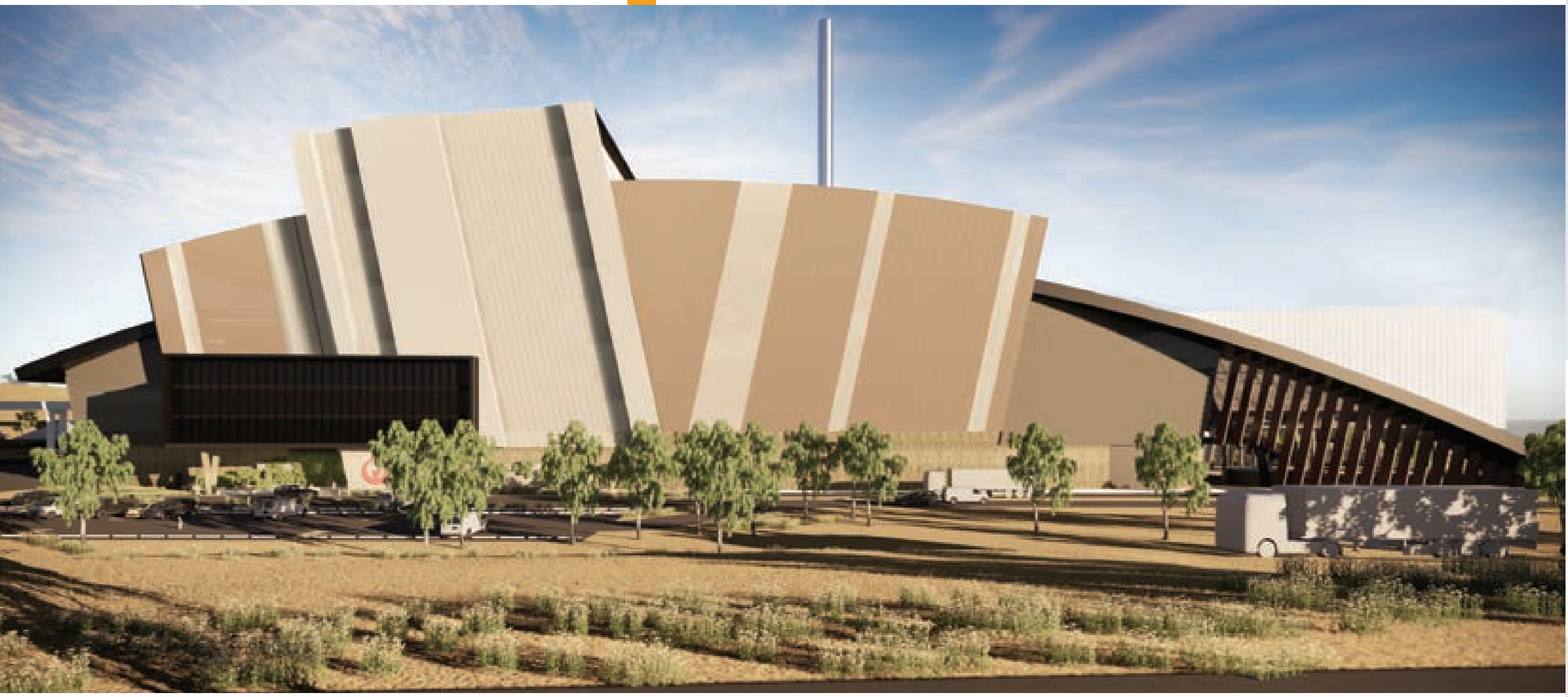
“And in terms of the flue gas treatment, this is treating the gases down to a very fine level and being continuously monitored.”

Both Holt and Kirkman believe that, now the technology has been introduced to Australia, it can be taken up much more rapidly.

“The actual technology itself – the combustion technology, the grate, the flue ›

“THREE TONNES OF WASTE EQUALS ABOUT ONE TONNE OF COAL. WE BURN THE WASTE, AND THEN THE HEAT ENERGY THAT’S RELEASED FROM THAT WASTE IS USED TO BOIL WATER.”

BELOW: Artist’s impression of a proposed Veolia waste-to-energy facility for New South Wales.



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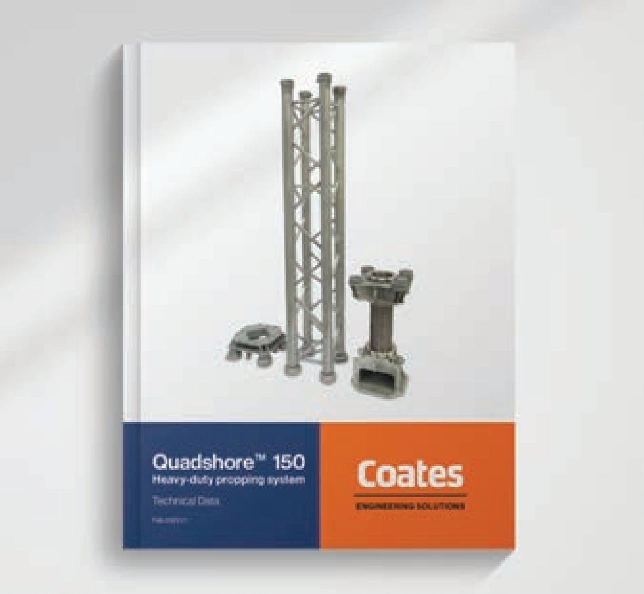

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gas treatment – all the different components that we need – plus the integrating pipework and electrical wiring to balance the plant – putting all those three elements together hadn't been done here before," he said.

"Once someone was able to get those two plants off the ground in WA, that really was a bit of a game changer. It gave everybody the confidence that it can be done."

Holt added that having had experience with other regulatory regimes helped smooth the way here too.

"A lot of the hurdles that have prevented the industry from being developed in the past have been regulatory and policy based," he said.

"ONCE SOMEONE WAS ABLE TO GET THOSE TWO PLANTS OFF THE GROUND IN WA, THAT REALLY WAS A BIT OF A GAME CHANGER. IT GAVE EVERYBODY THE CONFIDENCE THAT IT CAN BE DONE."

"WA regulation has traditionally been the most advanced in this space, which is why we've seen two facilities being developed [there]."

Kirkman expects Australia could eventually have between 10 and 12 of these facilities.

"Once we have the two operating in Perth, we'll be able to ... take people from New South Wales over to Perth [and say] 'have a look at this', you can see it's nice, shiny new technology; it's clean, it's safe," he said.

"Building them is challenging; some people do not want to be near them. But once they're built, I've never been in a position where we have anyone concerned, because they're benignly operating without any impacts." ●

PICTURED: Veolia waste-to-energy facilities in the UK at Newhaven, (top), and Portsmouth, (above left).

Aggregate advantage

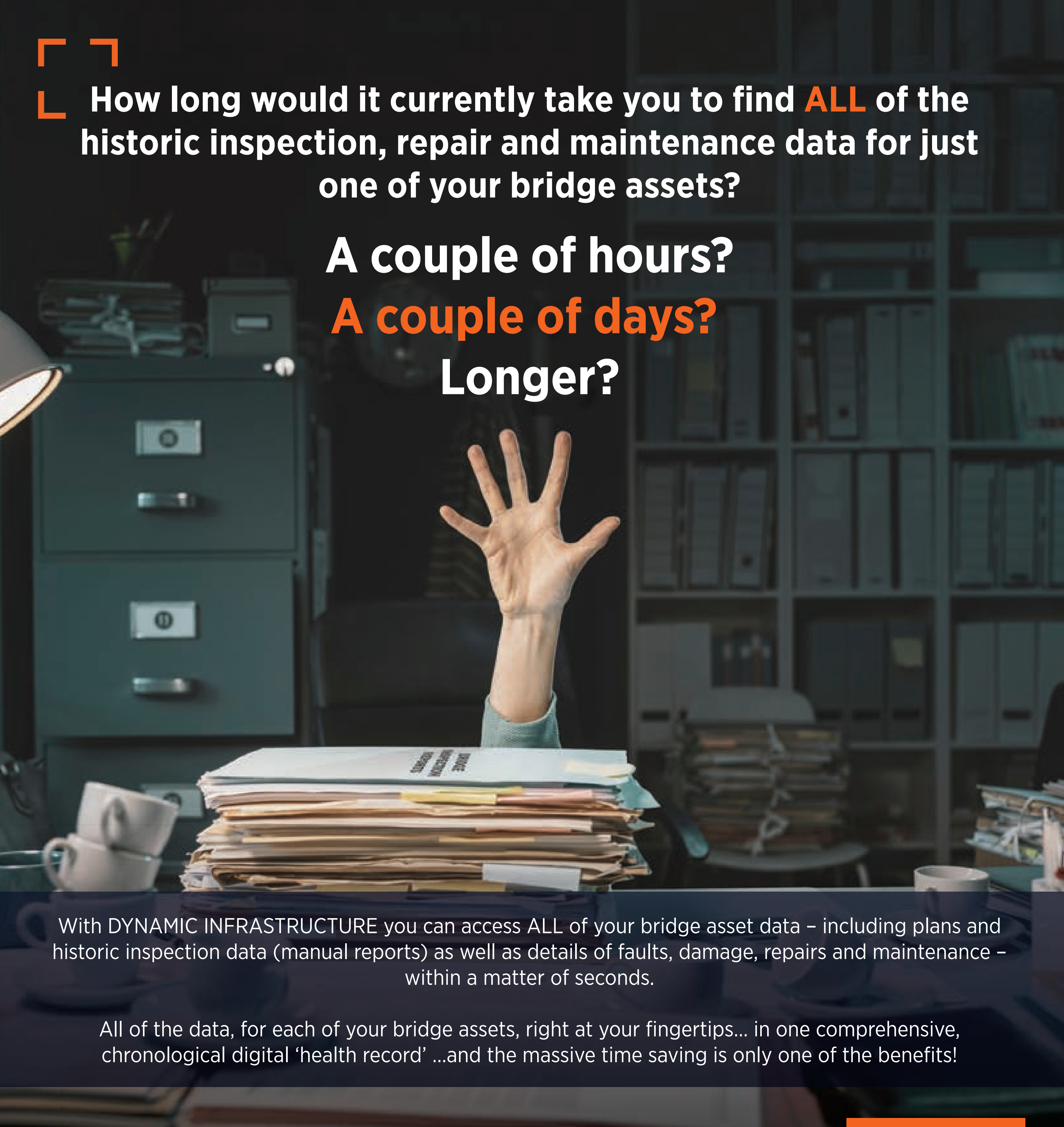
—

Operators of waste-to-energy plants also keep a close eye on the outputs from the process.

Danish plant Amager Bakke hopes to make its carbon capture process so efficient that it can operate in a carbon-neutral manner, while Veolia and Ramboll plan to carefully treat the by-products of their Australian plants.

"As the waste combusts it leaves behind a residue or an ash product. Some of that — what we call the bottom ash — is non-hazardous, and can be used and reused in the construction industry," said Ramboll's Luke Holt. "The bottom ash from Kwinana will be sent to a facility that's just down the road from the Kwinana complex called Blue Phoenix, where they'll sort it, and they'll grade it, and then recover any more metals that are still in the ash — which are obviously a highly valued commodity.

"And then that aggregate ... the intention is to use that in the manufacture of retaining wall blocks as a substitution for limestone. This has the added benefit of reducing the use of limited limestone resources. These are the very large blocks that end up getting used in noise acoustic walls on freeways and highways."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WORDS BY **MICHELLE WHEELER**

ACCELERATED LEARNING

THE ENGINEERS AT THE AUSTRALIAN SYNCHROTRON IN MELBOURNE ARE DESIGNING TOOLS TO STUDY OBJECTS AT NANO-SCALE RESOLUTION.

ABOVE: Brad Mountford, Australian Synchrotron.

IN 20 years at the Australian Synchrotron, head of engineering Brad Mountford has seen some strange objects.

The instruments he has designed have been used to study an entire living tree, a rhinoceros skull and a fossilised dinosaur nest.

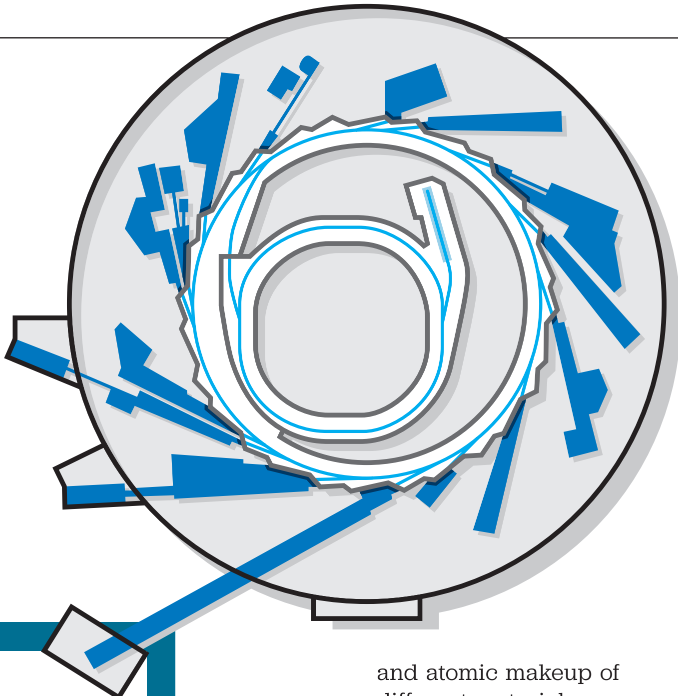
One day, an ancient Egyptian artifact might be in the building; the next, a Renaissance painting or a lunar meteorite.

"One of the beauties of this place is some of the strange things that come through the door," Mountford said.

The Australian Synchrotron, in Melbourne's south-east, is what's known as a particle accelerator. It's about the size of a football field and, from the outside, looks like a roofed sporting stadium.

The facility has been called a "super microscope" because of the extremely high-resolution imagery produced by its instruments.

But microscopy is only one aspect of the synchrotron, which is home to a host of tools for examining the molecular



ABOVE: The Australian Synchrotron.

LOOKING INSIDE

The Australian Synchrotron uses electricity to produce intense beams of light more than a million times brighter than the sun.

The light is produced when high-energy electrons are forced to travel in a circular orbit inside the synchrotron tunnels by the "synchronised" application of strong magnetic fields.

This electron beam travels just under the speed of light — about 299,792 kilometres a second.

"Synchrotrons are designed to accelerate electrons up to virtually the speed of light and use them to generate X-rays," Mountford said.

"So the synchrotron itself is actually just a source of X-rays."

The X-rays come off the synchrotron and are channelled into beamlines. Each beamline is tailored for a different type of experiment, ranging from imaging to spectroscopy, crystallography and fluorescence.

and atomic makeup of different materials.

Australian Synchrotron mechanical engineer Becky Lin said the synchrotron produces light, and then uses that light to do scientific research.

"We accelerate electrons really, really fast," she said.

"The light that comes off at a tangent ... we use different parts of it to analyse different samples."

The light is channelled down long pipelines, known as beamlines, into a suite of scientific instruments. It's used by scientists from universities, other research institutes and industry.

Researchers typically apply for time on the synchrotron, with projects awarded access to the beamlines based on merit. There's also a small proportion of users – such as for-profit drug companies – who pay to use the instruments.

The facility is one of only two synchrotrons in the Southern Hemisphere; the other is in Brazil.

In designing each beamline, Mountford said the engineering team concentrates on the area where samples go.

"We pay a lot of attention to what's called the end station, which is where the experiment actually happens," he said.

"And we design them to have an incredible amount of flexibility – within reason – to accommodate all potential scenarios that might be requested of that beamline in the future.

"I would suggest we've been pretty successful at that to date. We've never had to tear a beamline apart to build it for a particular experiment, but we've had some very, very strange experiments happen."

BREATHTAKING WORK

Associate Professor Martin Donnelley is a biomedical engineer researching X-ray imaging and cystic fibrosis at the University of Adelaide.

In August, his team won a Eureka Prize for work that put live rats in the synchrotron's imaging and medical beamline.

The researchers had to overcome a host of challenges associated with imaging live animals outside of a biological lab.

But their efforts paid off with a new technique for imaging the lungs of young children with cystic fibrosis.

Donnelley explained cystic fibrosis is a recessive genetic disease that causes dehydration of the airway surfaces.

"It means that anything that you breathe in sticks to this sticky mucus that's there," he said.

"Bacteria can grow really well in it – you get these bacterial infections that, over time, destroy lung tissue."

Donnelley, who works in Respiratory Medicine at Adelaide's Women's and Children's Hospital, said the most common lung function test for kids with cystic fibrosis is called "spirometry".

It's a 100-year-old test that sees children blow into a spirometry device to measure "forced expiratory volume": essentially the amount of air they can get out in one second.

"You have to breathe in as much as you can and then, as quickly as you can, get all the air out of your lungs," Donnelley said.

"And so kids under five or six years of age can't do that test."

The alternative is a CT scan, but doctors don't like to do too ›

"WE'VE NEVER HAD TO TEAR A BEAMLINE APART TO BUILD IT FOR A PARTICULAR EXPERIMENT, BUT WE'VE HAD SOME VERY, VERY STRANGE EXPERIMENTS HAPPEN."

IMAGES: ANSTO

many CT scans on children because they come with a dose of ionising radiation.

Instead, Donnelley and his colleagues were able to use the synchrotron to track the motion of lung tissue throughout the breath cycle.

The new technique is called "X-ray velocimetry", and it allows doctors to visualise where air is flowing in a lung and better calculate ventilation.

"You can actually generate a coloured map of airflow at different parts of the lung," Donnelley said.

LIVE BROADCAST

Donnelley and his team spent a long time developing tools and techniques to image live animals at the synchrotron.

"Early on, we faced a lot of challenges in figuring out how to make biological experiments work really well in a physics facility," he said.

In the lab, for instance, scientists can easily administer a substance to a rat and observe what happens.

But at the synchrotron, where researchers are isolated from the experiment because of the radiation, they had to develop ways to do it remotely.

"Then we have to do a lot of things like physiological monitoring, to make sure that our animals are healthy and okay even though we can't directly see them in front of us," Donnelley said. "We need to make sure that they're kept warm, [have] fluids, and we monitor their ECG and respiration and temperature."

The team developed novel ways of detecting breathing, using sensors to pick the exact point in the breath they wanted to capture images.

They also got really good at identifying landmarks within a rat to position the field-of-view – which could be just one square millimetre – in just the right place.

Donnelley admits there were days the team reflected that they wished they'd taken up imaging geological samples instead.

"It just seemed so much easier sometimes," he said.

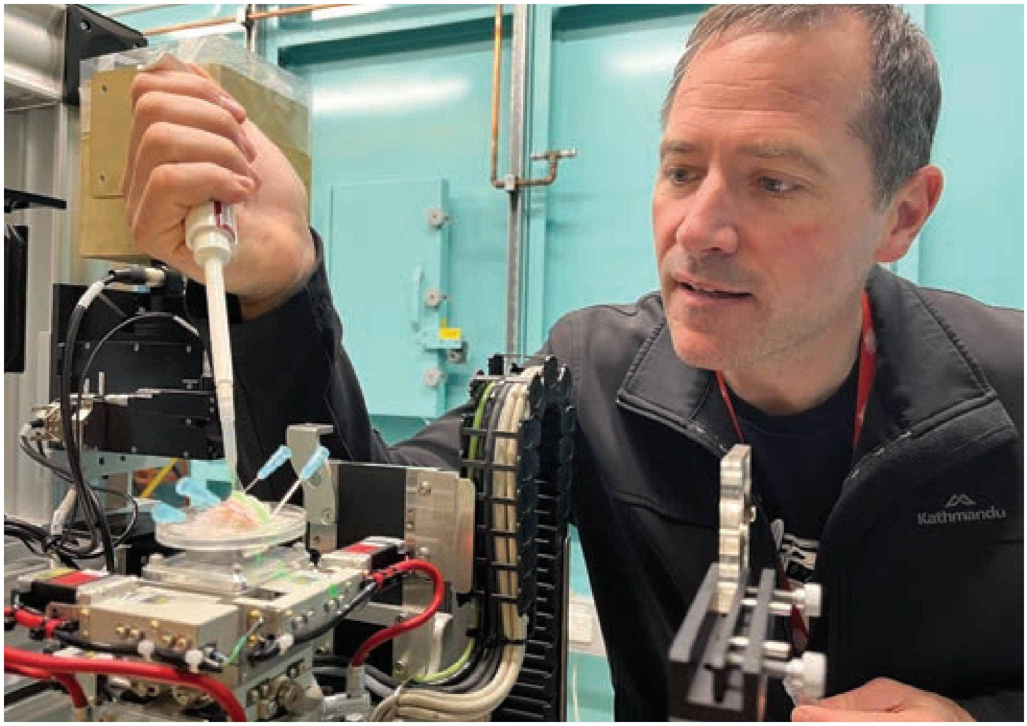
But their work has paid off, and the technology is currently being commercialised through Melbourne company 4DMedical – with whom Donnelley is a shareholder.

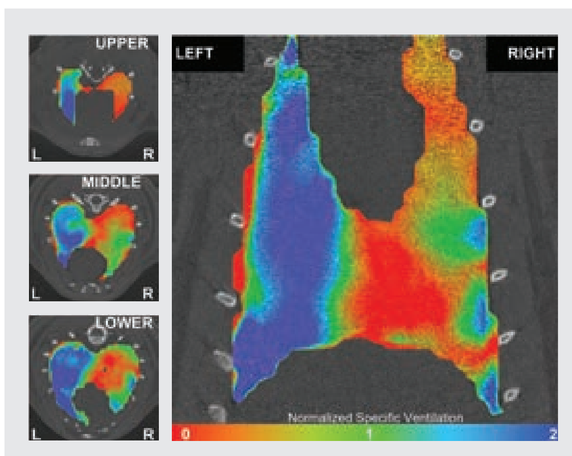
On the clinical side, the researchers are now recruiting children with and without cystic fibrosis to gather baseline data on what their lungs look like.

Donnelley is also conducting a paediatric X-ray velocimetry feasibility study with the children's hospital in Adelaide.

Donnelley said the research is uncovering children who score well on traditional tests but whose lungs are struggling.

"One of these kids has this spirometry value – FEV1 – of 96 per cent," he said.





ABOVE: Associate Professor Martin Donnelley (top) used the synchrotron to image live rats.

"EARLY ON, WE FACED A LOT OF CHALLENGES OF FIGURING OUT HOW TO MAKE BIOLOGICAL EXPERIMENTS WORK REALLY WELL IN A PHYSICS FACILITY."

"IT HELPED US TO UNDERSTAND SOME EFFECTS OF DIFFERENT PARAMETERS ON THE DISTRIBUTION OF THE GEOPOLYMER GELS, OR THE HOMOGENEITY OF THAT DISTRIBUTION."

"So we would say lung function is normal. But when we look at the ventilation map ... we can pick areas within the lung where there's reduced ventilation."

Donnelley said the human lung is very resilient. "We saw this during COVID, that people can be really, really sick but the lung still manages to cope, to keep you alive," he said.

Lungs can also compensate. If one area of the lung isn't performing as well as it should, another can increase performance to make up for it. That's something the researchers can see with the new imaging technique.

"It's data that we've never been able to acquire before and never been able to see," Donnelley said. "So being able to identify these changes is really exciting."

Donnelley said the technology can also be used for other respiratory diseases, including asthma and chronic obstructive pulmonary disease.

"Hopefully, it'll become that new technology that, instead of going and getting a CT or a lung function test, you go and get this [X-ray velocimetry] scan," he said.

SUSTAINABLE CONCRETE

Associate Professor Ailar Hajimohammadi is leading research at the UNSW Sydney that could overhaul one of the world's major carbon dioxide-emitting industries: cement.

She's developing sustainable concretes that can reduce carbon emissions by up to 80 per cent. Her materials combine geopolymers with industrial glass and sand wastes to produce high-performance green concrete for the Australian construction industry.

ABOVE: Associate Professor Ailar Hajimohammadi (left); Geopolymer concretes.

Hajimohammadi was awarded time on the Australian Synchrotron to understand the chemical bonding structure of the green concretes.

Using the synchrotron's infrared microspectroscopy beamline, she was able to study the local chemistry of the material and how the geopolymers interact with the glass.

"[It] helped us to understand some effects of different parameters on the distribution of the geopolymer gels, or the homogeneity of that distribution, or the interface of the binder with the aggregates," Hajimohammadi said. "They're things that we cannot really do in the lab."

Concrete is the most widely used human-made material in existence. The industry is responsible for eight per cent of global emissions – far greater than aviation.

To create green concrete, Hajimohammadi uses industrial by-products and other waste materials that are high in alumina and silica. She then activates them with an alkaline product that helps everything bind together.

Along with their environmental benefits, Hajimohammadi said geopolymer concretes perform well in aggressive environments. She said they are very durable in acidic or salty environments, compared to normal concrete.

"It can have very good high temperature resistance or fire resistance … it has been used as a coating against fire as well," Hajimohammadi said.

She said geopolymer concrete can also be manipulated and customised to give it different characteristics, such as higher strength or long-term durability.

Hajimohammadi is working on a project with construction company John Holland that will use waste glass to develop geopolymer concrete for paving.

She's also collaborating with Transport for NSW and Jacobs to explore structural applications for the materials.

For Hajimohammadi, who has been studying geopolymer concretes since 2007, broader use of geopolymers concretes can't come soon enough.

She wants industry, academia and government to work together to speed up adoption of the technology. "That is what I'd like to see happening quicker," Hajimohammadi said.

NANOMETRE PRECISION

Mountford started working at the Australian Synchrotron in 2003, when the facility was little more than a series of concept drawings and artist's impressions.

A few months earlier, the synchrotron and its first employees had featured on the cover of the Engineers Australia magazine of the day.

Today, Mountford and Lin are working on the design of new beamlines as part of the synchrotron's Project BRIGHT upgrades.

One is a new nanoprobe beamline that will allow scientists to see fine structures at resolutions as low as 15 nanometres. That's about 5000 times smaller than the thickness of a single sheet of paper.

"It's going to use a nano-focused X-ray beam to focus on almost individual atoms, and get them to fluoresce," Mountford said. "That fluorescence can tell you a lot about what they are."

Designing a beamline with such a small focus is a huge challenge.

"You have to consider things like ambient air temperature, air movement, we even have to consider the solar load on the building itself," Mountford said.

"If you want to go really, really small, your problem space gets really, really big, and you have to start considering things that you wouldn't have had to normally think about."

The team tries to eliminate interference where they can, but it's not always possible.

"IF YOU WANT TO GO REALLY, REALLY SMALL, YOUR PROBLEM SPACE GETS REALLY, REALLY BIG."

"You can't eliminate ground vibration, for example, so you have to spend a lot of time trying to find a way to isolate it or mitigate it," Mountford said.

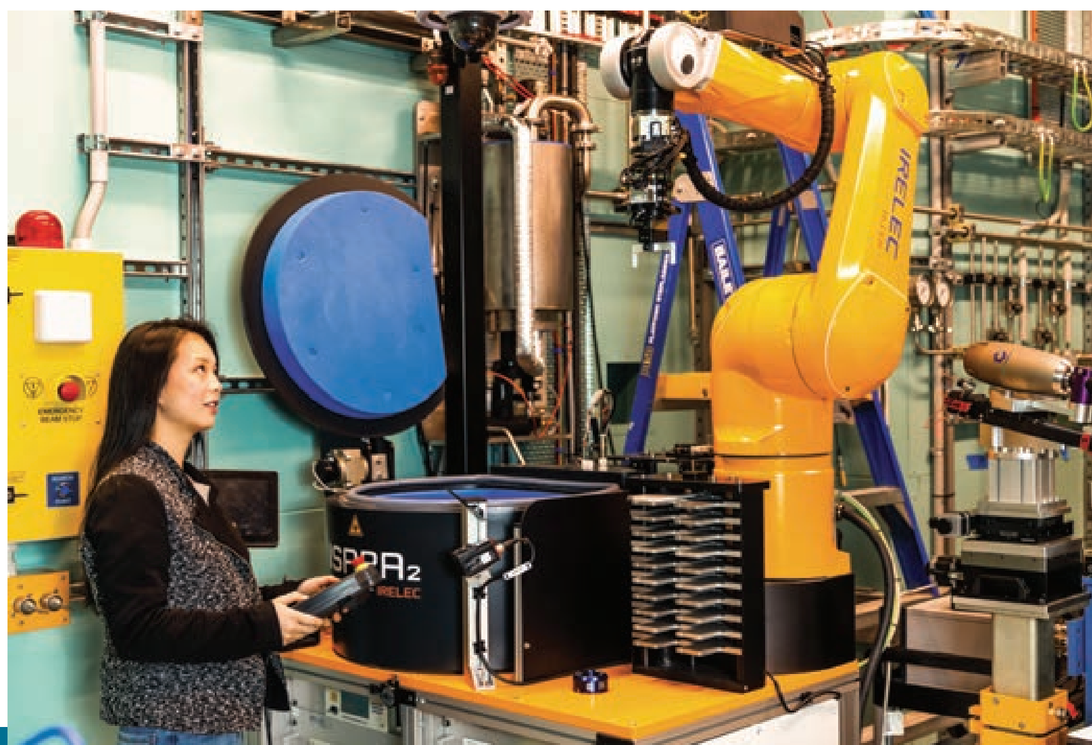
"Putting damping in and under a structure to dampen the vibration – there comes a point where that's no longer effective, and you have to start implementing another solution on top of that. And that's when you start looking at things like active feedback."

Lin said working at the synchrotron means finding solutions for engineering problems not faced elsewhere.

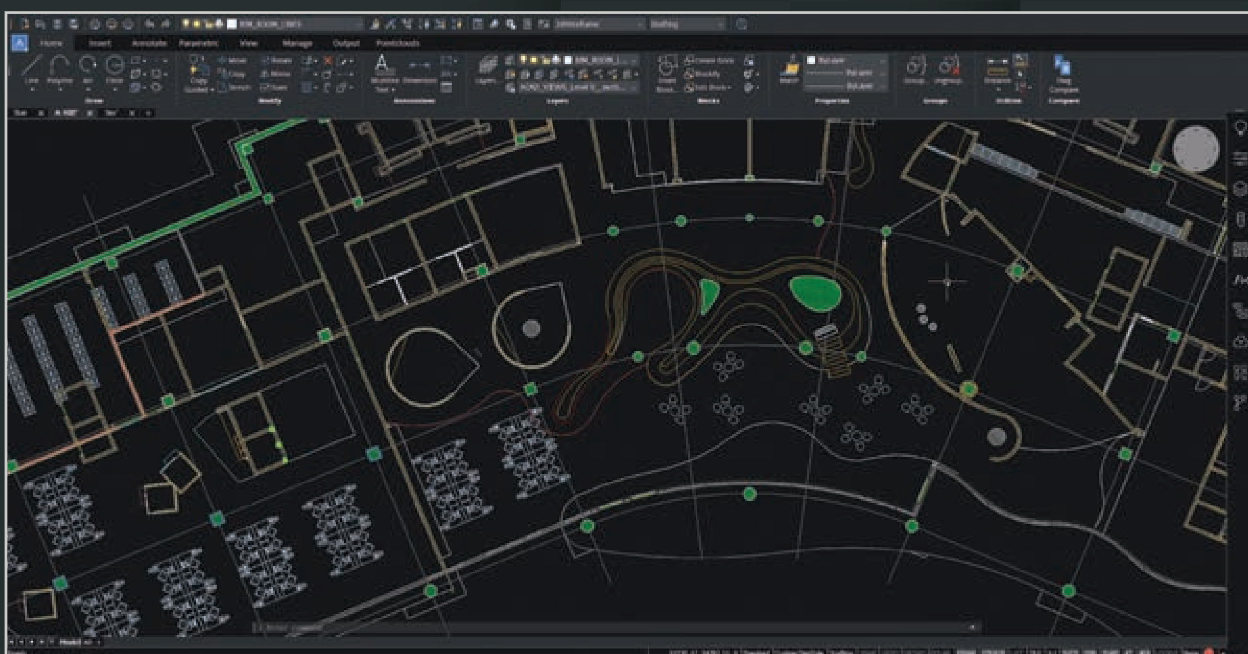
"You're always learning new and complex scientific things," she said.

Mountford still doesn't consider himself an expert.

"I always tell the new starters on my teams – don't try and learn it all at once, because you'll never learn it. It's a bottomless pit of both interesting experiments and – from an engineering point-of-view – an interesting set of challenges. It just changes so much." ●



BELOW: Becky Lin, Australian Synchrotron.



WORDS BY **SUSAN MULDOWNEY**

CROPPING UP

CAN LIFE EXIST ON THE MOON? A GROUP OF SCIENTISTS AND ENGINEERS IN AUSTRALIA IS CREATING A HYPERBARIC CHAMBER TO PROVE THAT GROWING PLANTS IN SPACE IS POSSIBLE.

THE AUSTRALIAN Lunar Experiment Promoting Horticulture (ALEPH) project, led by start-up Lunaria One, has received $3.6 million from the Australian government to investigate if plants can grow on the lunar surface.

Seeds will be transported to the moon in a specially designed, shoebox-sized chamber aboard a lunar lander scheduled for a mission as early as 2025.

Hermetically sealed and equipped with sensors, water and a camera, the chamber's design has presented challenges. However, Lunaria One's co-founder and engineering lead for the project, Dr Graham Dorrington, said it has the engineering minds – and facilities – to succeed.

"The basic mission is: can we germinate something in a small, closed vessel in 72 hours from a dried seed state?" said Dorrington, an aeronautical engineer and senior lecturer at RMIT's school of engineering.

"One of the main engineering challenges is controlling the temperature when it arrives on the moon, but we think we've solved that problem."

LUNAR LESSONS

A better understanding of our only natural satellite may help to address challenges back on Earth.

Located roughly 384,000 km from home, the moon is a relatively close neighbour and is connected to our planet in various ways, such as its influence on ocean tides.

Growing plants on the moon will provide valuable insights into their adaptation in challenging environments, and will help in the development of sustainability strategies for future life both here and in space.

"I've long thought that we're a part of an Earth-moon system and I've been conscious of dimensions that haven't been explored, in terms of the quality of life on Earth, how we conduct our lives and how the moon could be involved in that," said Dorrington.

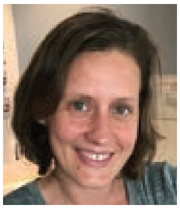
ANU Associate Professor Caitlin Byrt, who is a science advisor for Lunaria One and an ARC Future Fellow at the ANU Research School of Biology, said the mission may also unlock new methods to boost sustainable food production on Earth and support food security in the face of climate-driven weather disasters.

"Understanding what resources you would need to quickly propagate food in the case of a disaster is a really exciting challenge and one that will become increasingly important," she said.

Byrt explained that a range of plant species are being considered for the mission, including resurrection plants, which are naturally adapted to desert environments.

"They have this extraordinary feature where some of them can become dehydrated down to just 10 per cent of their normal moisture content, which is a condition that most organisms can't survive," she said.

"But they've evolved to get really dry, pause their metabolism and sort of go into stasis. Then, upon watering, they regrow again."



ABOVE (from top): Associate Professor Caitlin Byrt, ANU; Dr Graham Dorrington, RMIT. BELOW: Lunaria One's hyperbaric chamber.

INSIDE THE CHAMBER

The chamber that will house the seeds is made from aluminium and weighs no more than 1.5 kg. Dorrington describes it as "basically a tin can".

It will operate on minimal power while transmitting data via the lunar lander back to Earth and will use data rates of less than 40 Kb per second.

"We're hoping to carry temperature and pressure sensors, and maybe an oxygen sensor," said Dorrington.

"The problem is it all adds complexity and time and they're not essential for the experiment, because our primary objective is to demonstrate that we can create a thermal environment that is conducive to seed growth."

Dorrington explained that because air pressure inside the chamber must remain quite high, hermetic sealing is essential.

"We can't use sealants that aren't bio friendly, which was a bit of a challenge, but it was just about the correct use of O-rings," he said.

A bigger challenge, said Dorrington, is activating a valve at the right time to release water for the plants.

"We need to wait until we've got the right temperature – and, hopefully, that's soon after landing, because we've got a very limited window – and then we'll

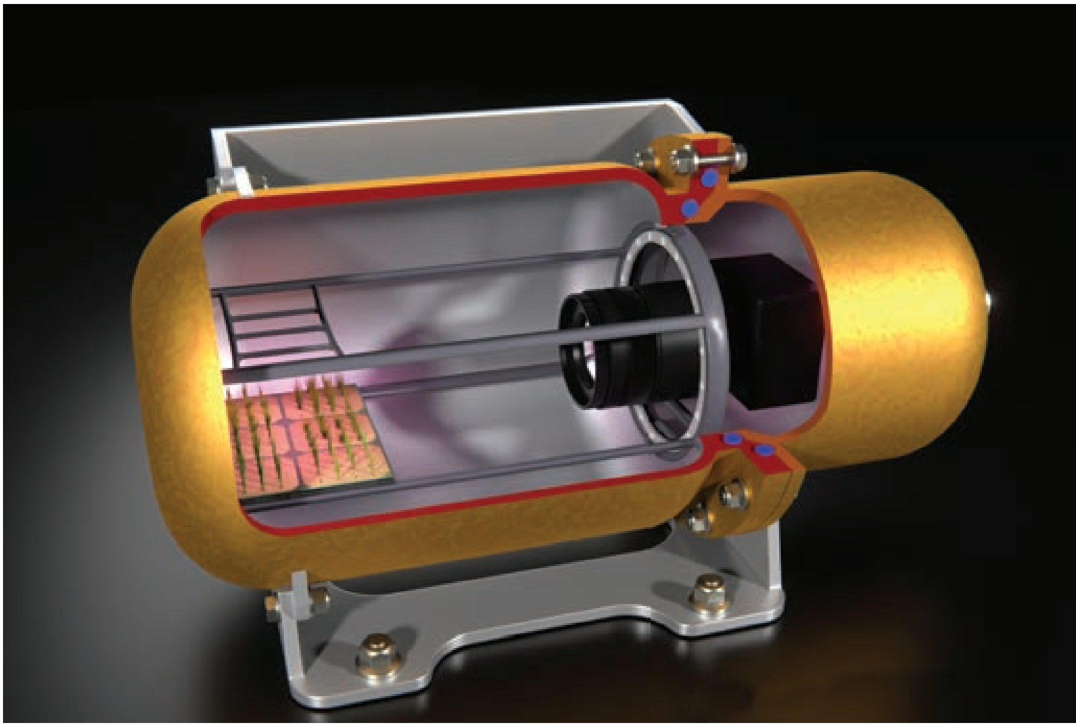


IMAGE: ARTHUR GEORGALAS, RMIT UNIVERSITY 2022.

"ONE OF THE MAIN ENGINEERING CHALLENGES IS CONTROLLING THE TEMPERATURE WHEN IT ARRIVES ON THE MOON – BUT WE THINK WE'VE SOLVED THAT PROBLEM."

immediately release all the water," said Dorrington, adding that the volume will depend on the final plant selection, but expects it to be roughly 20 mL.

TEMPERATURE CONTROL

A mission to grow plants on the moon is not new. A sprouting cotton seed on China's Chang'e 4 lunar lander in 2019 was the first plant to germinate on the moon, but lunar night temperatures proved too low for it to survive.

On the lunar surface, the temperature fluctuates from highs of 80°C to lows of -180°C.

"The payload has to be on the lunar surface by early in the morning, because as soon as the sun rises on the moon, it's got about the right temperature, depending what latitudes you are on the moon," said Dorrington.

"We're looking at moderate latitudes where the temperatures are manageable. But, soon after landing, the temperature in our chamber will rise quite rapidly and it's almost exactly the same conditions as you get in a desert, with severely cold nights and midday heat, where it gets to about 40°C."

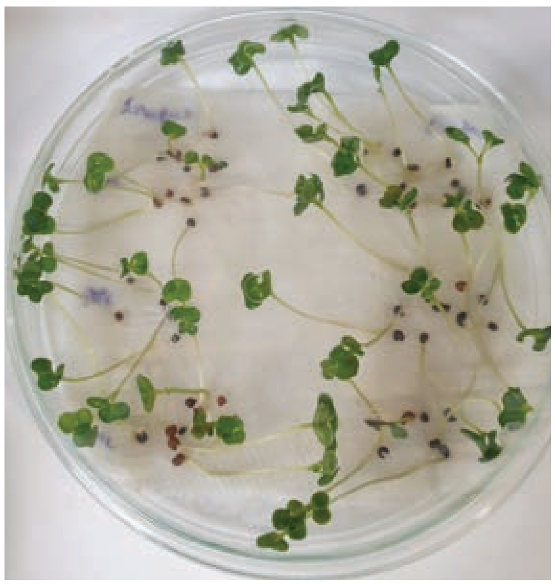
Controlling the temperature in the chamber has been an engineering challenge, but Dorrington and his team are attempting to solve it using a modulated optical surface reflector.

"It will cool the payload down more quickly, and we will also put in one or two watts of power, which means we can also keep the chamber warm," he said.

"We're working with very tight power constraints, and we can't have too much heat going into the chamber when it's getting to the hot end.

"Another thing is how we insulate the chamber and what materials are used. We still haven't decided that, but it can make quite a difference. We've got a tight deadline and it all has to be built and qualified."

Dorrington said the qualification process is proving to be the greatest engineering challenge of the Lunaria One mission.



"WE'RE WORKING WITH VERY TIGHT POWER CONSTRAINTS, AND WE CAN'T HAVE TOO MUCH HEAT GOING INTO THE CHAMBER WHEN IT'S GETTING TO THE HOT END."

"You have to get the chamber approved for launch, so you have to put it through vibration and thermal vacuum testing, and all sorts of other tests to ensure it's safe," he said.

"One of the things that's not really liked in the space world is a pressurised container," adds Dorrington.

"Most little cubes that go into space don't have any gas stored in them and lots of launch providers don't allow that, so we have to do a lot of structural analysis on the pressure of the vessel so it can't possibly rupture."

The Lunaria One team must deliver the payload one year before launch and, Dorrington said, at a mere 1.5 kg, it's quite demanding.

"I thought at first it was going to be easy, but it's actually quite hard," he said.

"But if we can demonstrate that we can do this, the next logical step would be: can we dig up the lunar regolith and plant seeds on the lunar surface?"

ABOVE: ***Brassica napus*** **is one plant being considered for the mission.**

LIGHT OF THE MOON

In April 2022, the experiment proposed by Lunaria One was selected by non-profit aerospace organisation SpaceIL to be included as one of the payloads on board its Beresheet 2 lander.

Lunaria One's team draws on expertise in biology, engineering, psychology and education. Its mission is a collaboration between institutions such as Queensland University of Technology, RMIT University, the Australian National University and Ben-Gurion University in Israel, as well as industry bodies.

Data from the Lunaria One mission will be beamed back to Earth to allow citizen scientists and school children to conduct their own experiments into which plant varieties have the best chance of growing on the Moon.

"We wanted a project that young people would easily identify with," said Dorrington.

"Going to the moon to see if plants can grow, there is a very tangible outreach objective to explain to eight to 12-year-olds, and that's a very important age range to influence perceptions of what STEM is about."

IMAGE: TIEN HUYNH

WORDS BY **CHLOE HAVA**

RENEWAL FROM RUIN

A NEW DEVELOPMENT ON A FORMER MELBOURNE LANDFILL DEMONSTRATES THE ONGOING BENEFITS OF URBAN REGENERATION.

BUILDING A new community on a former quarry and landfill site is no mean feat.

But real estate developer Riverlee and a team of engineers have managed to pull it off.

The $2 billion New Epping development, 18 km north of Melbourne's CBD, is designed to be a "city within a suburb", complete with residential neighbourhoods, commercial spaces, and a health, wellness and knowledge precinct.

Encompassing 51 ha, the development will provide housing, employment and commercial opportunities to the suburb, revitalising a twice-used site that may otherwise have lain dormant.

"This is a true urban renewal and regeneration story," David Lee, Development Director at Riverlee, said. "It will drastically improve the local environment while also creating a community that will redefine the area in terms of urban experience and wellness."

Two of the mixed-use project's 30 buildings are now complete, but the end results didn't come easy.

ABOVE: The New Epping development is designed as a "city within a suburb".

DILAPIDATED AND DERELICT

When Helia EHS General Manager Jeremy Newstead was engaged by Riverlee to assess the land chosen for the New Epping site, he found it completely derelict.

One of the holes at the former basalt quarry was filled to surface level with general rubbish to depths of as much as 18 m.

"While today's landfills are a lot more heavily engineered, fully lined with gas and leachate collection systems, the old landfill contained waste directly connected to the earth beneath the rock," Newstead said.

To get the site up to scratch in terms of safety and stability, there were several issues to overcome, including geotechnical challenges due to the ""uncontrolled fill" in the landfill.

"If you're going to place pressure on top of a landfill, such as a building, this can cause issues with differential settlement," Newstead said.

Given the large mass of buried waste on the site, the team had to contend with environmental issues, including leachate that potentially contaminated

> "THE TOTAL VENTING VOLUME WAS ALSO DESIGNED TO ACCOUNT FOR ANY DOWNTIME IN THE PASSIVE SYSTEM, SO THE CONCENTRATIONS OF GAS REMAIN WITHIN SAFE LEVELS."

SAFETY FIRST

To ensure the buildings in Melbourne's New Epping development were safe to inhabit, quality assurance, verification and monitoring was conducted at each step along the way.

During construction, an independent inspector supervised the installation of the venting system to ensure it conformed with the design.

"The independent inspector then verified the manufacturer's quality assurance and installation of the gas membrane," Lucas added.

Once the slabs were poured, the venting system was also verified to check the gas concentrations were at safe levels.

Monitoring the site is a continuous process, which includes detecting changes in the groundwater onsite and offsite, rectified with pump-and-treat groundwater remediation.

the natural groundwater and surrounding surface waters.

To overcome the geotechnical challenges, the buildings constructed on top of the waste were piled down to the basalt solid rock and fastened by a slab, mitigating any opportunity for settlement. Tackling the environmental issues required rigorous assessment to test the soil, groundwater, leachate and creek banks.

"We implemented some leachate groundwater pumping systems to manage any migration of contamination," Newstead said.

IT'S A GAS

Landfill is dynamic in nature in terms of gas generation, said Core Environmental Projects Technical Director James Lucas, who consulted on the gas protection and interception design in the first stage of New Epping.

When landfill gases such as methane or carbon dioxide are disturbed, they can be released, posing potential health hazards to people in the buildings above.

To mitigate the impact of landfill gases, the team developed three lines of defence, with venting, a robust gas membrane and structural elements.

The venting system is passive, minimising ongoing maintenance and energy costs. It is driven by whirlybirds to collect any gas surfacing from the ground and then diluted under the membrane.

"Eventually, all the mixed diluted gas ends up venting at a concentration well below any level of concern in a safe space on the building rooftops," Lucas said.

The inlets around the perimeter of the buildings have been coordinated to let air in, and the vent pipes travel through dedicated venting shafts.

"Given the amount of gas underneath the buildings, we wanted to double check the passive venting system would be enough, so we examined thermal buoyancy and wind effects on several venting layouts using computational fluid dynamic modelling to optimise the venting system on the first building," Lucas said. "The total venting volume was also designed to account for any downtime in the passive system – for example, in low wind conditions – so the concentrations of gas remain within safe levels."

ABOVE: Edgars Creek Reserve (top) and a residential neighbourhood in New Epping.

LARGE-SCALE BENEFITS

Before the restoration, Edgars Creek, which runs through the site, was in disrepair, plagued by overgrown weeds.

"Now, the creek has been revitalised, with a new habitat built for the growling grass frog," Newstead said.

"We've also been able to improve the groundwater quality through onsite soil remediation."

Without the New Epping development, the site would have likely remained derelict.

"Through the environmental investigation, assessment and remediation that's required for development, it's actually rehabilitating the land," Lucas said. ●

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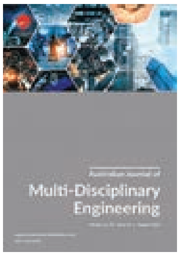
HIGHLIGHTS FROM AUSTRALIA'S MOST UP-TO-DATE ENGINEERING RESEARCH

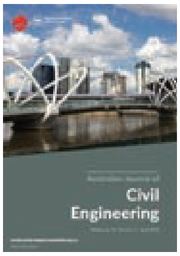


A MACHINE LEARNING APPROACH FOR DIGITAL WATERMARKING

Journal: *Australian Journal of Multi-disciplinary Engineering*
Author: M. A. Nematollahi

—

Machine learning is increasingly being used to model the behaviour of complex systems. Although researchers in the watermarking and data-hiding field compete to develop more efficient algorithms, selecting the most efficient one is almost impossible for industries or software developers. This paper proposes two approaches to train deep learning and shallow learning models based on state-of-the-art watermarking techniques.

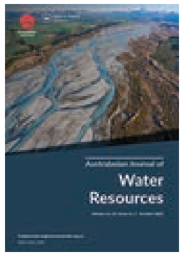


DEVELOPING A NATURE-BASED COASTAL DEFENCE STRATEGY FOR AUSTRALIA

Journal: *Australian Journal of Civil Engineering*
Authors: R. L. Morris, E. M. A. Strain, T. M. Konlechner, B. J. Fest, D. M. Kennedy, S. K. Arndt & S. E. Swearer

—

Australia's rapid coastal population growth coupled with the increased risk of hazards driven by climate change creates an urgent need to start adaptation planning for the future. This paper looks at recently implemented pilot trials showing a need to integrate industry-accredited guidelines into coastal management and government policy.

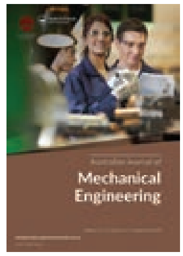


FROM PRIDE AND PREJUDICE TOWARDS SENSE AND SENSIBILITY IN CANTERBURY WATER MANAGEMENT

Journal: *Australasian Journal of Water Resources*
Authors: M. Robson-Williams, D. Painter & N. Kirk

—

In the decade following 2000, water management in the Canterbury region of Aotearoa New Zealand was characterised by irrigation expansion, agricultural intensification, and first-come first-served water allocation. In this paper, the authors examine water management in Canterbury through this case study in the Selwyn Waihora Zone.



Mechanical properties, thermal and chemical effect of polymer cotton bars reinforced with carbon/glass fiber

—

Journal: *Australian Journal of Mechanical Engineering*
Authors: K. A. Abdullah, A. I. Abdullah, A. A. Abduk-Razzak & M. Al-Gburi

The goal of this paper is to create low-cost bars with comparable mechanical performance and corrosion resistance to steel reinforcement. Many researchers are interested in using natural fibres to treat bars due to recent advancements in polymer characteristics. The mechanical properties of three types of bars are studied in this paper: cotton fibre-reinforced polymer bars, cotton/carbon fibre-reinforced polymer bars, and cotton/glass fibre-reinforced polymer bars. The bars were made using two methods: fibres immersed in polymer and fibres coated with polymer by repeated tension and relaxation of fibres. The second method produced better results in terms of tensile strength, and the stress–strain curve revealed brittle behaviour for all bars.

BELOW RIGHT: Failure shape for Cot.FRP, Cot.CFRP, and Cot.GFRP bars.

BEFORE FAILURE

FINAL FAILURE SHAPE

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CONFERENCES & EVENTS | NOVEMBER 2023 – MARCH 2024

07-09
NOV 2023
IMC INTERNATIONAL MARITIME CONFERENCE

Location: in-person *Sydney*
Website: *indopacificexpo.com.au/IMC2023*
Conference delegates will discuss the latest developments in naval architecture, marine engineering and maritime technology in the areas of defence and commercial shipping.
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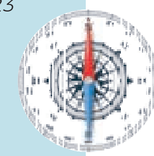


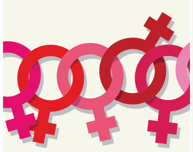
13-15
NOV 2023
HYDROLOGY AND WATER RESOURCES SYMPOSIUM 2023

Location: in-person *Sydney*
Website: *engineersaustralia.org.au/hwrs2023*
Innovation, collaboration and engineering excellence come together for HWRS 2023, with this year's theme "Living with extremes". Topics cover the spectrum of engineering hydrology and the progress made in understanding the uncertainties facing water resources managers now and in coming decades.
Register now

07-09
FEB 2024
11TH AUSTRALASIAN CONGRESS ON APPLIED MECHANICS (ACAM 2024)

Location: in-person *Brisbane*
Website: *engineersaustralia.org.au/acam2024*
ACAM 2024 aims to bring together engineers, academics, postgraduate scholars and industry managers to share research and development in all aspects of applied mechanics.
Early-bird registrations close 22 December 2023

05-08
MAR 2024
INTERNATIONAL WOMEN'S DAY EVENT SERIES



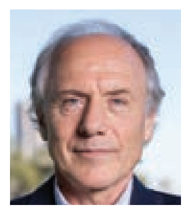
Location: in-person *Perth, Melbourne, Brisbane, Sydney*
Website: *engineersaustralia/iwd*
Keynote speaker Jamila Gordon, founder and CEO of Lumachain, will share her inspirational journey from being virtually homeless in Kenya to becoming a globally recognised startup founder. Join us as we recognise and celebrate positive action to address the challenges facing modern women in the workforce.
Register now

Climate Smart Engineering Conference 2023

29-30
NOV 2023

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

This month's CSE23 plenary and technical program includes some of the profession's brightest and boldest minds. Don't miss your chance to gain insights from thought leaders, connect with like-minded professionals and explore innovative solutions to tackle the challenges of climate change.



ABOVE:
Dr Alan Finkel AC.

Plenary speaker line-up includes:
Dr Alan Finkel AC, *former Chief Scientist of Australia*
Eytan Lenko, *Chief Executive Officer, Boundless Earth*
Amy Lezala Zahr *FIEAust EngExec, Chief Engineer, Rail, Department of Transport and Planning*
Dr Larry Marshall, *former CEO of CSIRO*
Lisa McLean, *CEO, Circular Australia*
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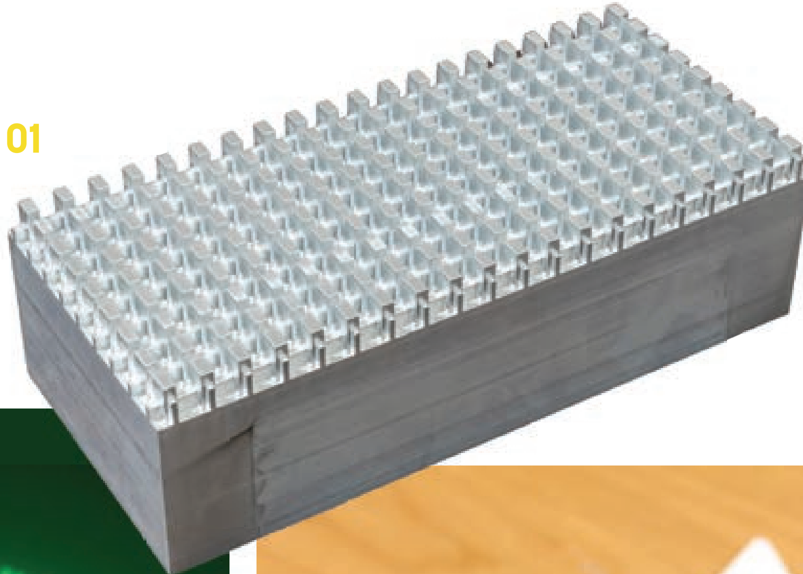
THE LATEST DEVELOPMENTS FROM AROUND THE WORLD.

01



02

03

04

01

Four-dimensional metamaterial

A render of a synthetic 4D metamaterial, which controls energy waves on its surface. Image: University of Missouri

A University of Missouri team has developed a four-dimensional synthetic metamaterial with properties that include the ability to control energy waves on its surface. Representing a fourth dimension in addition to the other three physical ones, these waves shape how vibrations move along solid materials. "Conventional materials are limited to only three dimensions with an X, Y and Z axis," said the University of Missouri's Guoliang Huang. "But now we are building materials in the synthetic dimension, or 4D, which allows us to manipulate the energy wave path to go exactly where we want it to go as it travels from one corner of a material to another." The metamaterial makes use of a technique called topological pumping, which allows waves to travel without being disturbed by defects in a material. The team sees uses for the technology in defence, microelectromechanical systems, and civil engineering, where it could be used to help prevent buildings from collapsing during an earthquake.

02

Cancer-detecting bacteria

This genetically engineered bacteria has turned green after being exposed to a tumour. Image: Associate Professor Susan Woods

A strain of bacteria has been genetically modified by researchers at the University of Adelaide so that it can signal the presence of colorectal cancer cells. By detecting mutated DNA released from the cells, the engineered *Acinetobacter baylyi* microbes make use of the bacteria's natural ability to integrate DNA from its environment. The team found that the sensor bacteria, named CATCH — or Cellular Assay of Targeted CRISPR-discriminated Horizontal gene transfer — could differentiate models with and without cancer cells with 100 per cent success rates. "CATCH has the potential to detect bowel cancer early, with the aim of preventing more people from dying of this and other cancers," said Associate Professor Susan Woods. "This study demonstrates how bacteria can be designed to detect specific DNA sequences to diagnose disease in hard-to-reach places." The team hopes CATCH will allow more diseases to be detected and prevented using cells rather than drugs.

03

Combustion-powered robot

The insect-sized robot gets its super-powered thrust by igniting a methane–oxygen mixture. Image: Cornell University

Engineers at the US's Cornell University have equipped a robot with a high-energy-density chemical fuel and soft microactuators to create an insect-sized device powerful enough to leap 600 mm into the air — 20 times its body length. This robot is made of a flame-resistant resin and pops into the air when a piece of silicone rubber is inflated by an ignited methane and oxygen mixture. "We thought using a high-energy-density chemical fuel, just like we would put in an automobile, would be one way that we could increase the onboard power and performance of these robots," said PhD student Cameron Aubin. "We're not necessarily advocating for the return of fossil fuels on a large scale, obviously. But in this case, with these tiny, tiny robots, where a millilitre of fuel could lead to an hour of operation, instead of a battery that is too heavy for the robot to even lift, that's kind of a no-brainer."

04

Smart speakers

The smart speaker "swarm" charging at its dock. Image: April Hong/University of Washington

A University of Washington team has developed a fleet of smart speakers that can divide rooms into different zones and track individual speakers. The resulting system can isolate sound from different parts of a space — a conference room, for instance — and allow users to mute some areas while focusing their attention on others. The technology uses a fleet of microphones carried on seven small robots that charge at a central spot before distributing themselves across a surface, such as a table. "If I close my eyes and there are 10 people talking in a room, I have no idea who's saying what and where they are in the room exactly. That's extremely hard for the human brain to process. Until now, it's also been difficult for technology," said doctoral student Malek Itani. "For the first time, using what we're calling a robotic 'acoustic swarm', we're able to track the positions of multiple people talking in a room and separate their speech."

Jennifer Hocking

CPEng, National Head of PMO
Yokogawa

FOR JENNIFER HOCKING, STEERING BIG PROJECTS TO SUCCESSFUL COMPLETION MEANS FOCUSING ON THE DETAILS.

WHEN JENNIFER Hocking began her career as a civil engineer, she didn't know she would end up specialising in project controls.

But when she found herself undertaking the role in a part-time position after returning from maternity leave in the mid-2000s, she found the work suited her perfectly.

"I absolutely loved it," she told *create*. "It just suits how my brain thinks."

Eighteen years later, her facility with schedules and value — the kinds of precise details that see her projects delivered consistently on time and under budget — has put her in the position of leading the national project management team at measurement and control engineering firm Yokogawa.

She brings to this position a long track-record of successful projects, and she takes pride in them having been executed precisely to plan.

"I'm a die-hard believer in the schedule," she said. "I think the schedule provides the answer to everything."

Take her work on a transportation project linking Mount Victoria to Lithgow, which she describes as a career highlight.

"I resourced the schedule with actual man hours, and to a value of $15 million," she recalled.

"And we invoiced from the schedule with accuracy to the nearest cent, which is quite an amazing feat."

03 TIPS FOR SUCCESS

1 Take up any offers of training, even if they seem trivial or time-consuming.

—

2 Make use of any free courses you might come across.

—

3 Seek to improve your emotional intelligence and time-management skills.

—

It also provided a warning: this project was set to lose money and run late. With this information, the project manager could take action.

"Most project managers, although they engage project controls, don't make decisions based on project control's reports," she said.

"He used that early warning system to make decisions and turn the project around and deliver it ahead of time and below budget."

It showed how taking care of the fine details can make a huge difference when millions of dollars are at stake.

That is one reason Hocking's career accelerated so quickly, seeing her take on greater responsibilities and supervising increasingly larger teams.

But she has also seen a change since she became a Chartered engineer.

"I've been given more senior positions very quickly, since being Chartered," she said.

"I was a senior scheduler at Jacobs and then became the team lead for project controls Eastern region — which was a decent sized team of 12 or more people. And then I jumped across to [Sydney City and SouthWest] Metro in their [Project Management Office] and managed four teams and up to 30 people."

Which brings her now to Yokogawa.

"It's very different to what I call 'horizontal engineering', meaning roads, rail, transport," Hocking said.

"Yokogawa's very much about improving how the plant operates." ●

IMAGE: SALTY DINGO

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