BRAVE MINDS

RESEARCH CHANGING LIVES | EDITION ONE 2019

NAILED IT!

THE INCREDIBLE 2,500-YEAR-OLD SHIPWRECK DISCOVERY REVEALING SECRETS OF A MARITIME EMPIRE

Flinders UNIVERSITY

GUT FEELINGS

Flinders researchers are linking the neural connections between the brain and gut to uncover clues of the gut-brain, health and wellbeing nexus.

GOING DEEP

Driverless cars may have captured our imagination, but autonomous marine vehicles have even bigger potential for change, both above and below the waterline.

RUNNING ON EMPTY

Guidelines created by Flinders hydrogeologists are leading the world in groundwater modelling that could help prevent cities like Cairo or Cape Town from one day running completely dry.

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WE LIVE IN AN AGE IN WHICH 'DISRUPTION' IS OFTEN SEEN AS A SOURCE OF FEAR AND WORRY. BUT TO FLINDERS UNIVERSITY RESEARCHERS – THE 'BRAVE MINDS' WHOSE WORK THIS MAGAZINE CELEBRATES – HARNESSING THAT DISRUPTION IS SOMETHING TO EMBRACE. IT IS A WAY TO CHANGE PEOPLE'S LIVES FOR THE BETTER.

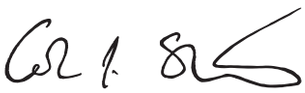
Flinders University researchers are tackling the big questions facing society with a scope that is truly breathtaking. New concepts are being examined and questioned, received wisdom is being reimagined or rethought, the past unearthed and the future confronted.

Some are working to understand the sheer wonder of the world around us, while others confront current challenges, whether that is the need to reduce energy use and waste, or how we can ensure the digital healthcare revolution results in the best outcomes for patients. Our people are drawing lessons from the past to contextualise the present, bringing new insights, for example, to the richness of Indigenous culture. They are discovering new commercial opportunities in the seas around us, creating high-tech smart homes that keep us healthier and happier as we age, and ushering in a new era of personalised medicine.

They are finding new ways to fight international crime, and overturning decades-old miscarriages of justice through their courage and tenacity.

But our magazine is more than just a showcase for the remarkable depth and diversity of our research. We hope you will find the stories in these pages inspirational, and that they will encourage you to join us in our journey of discovery, whether that is as a student, a collaborator or another valued member of the Flinders community. Flinders University is excited to be at the forefront of the world's most advanced thinking.

We are thrilled to be driving the growth of global knowledge and to be fostering new and better societies around the world.



PRESIDENT AND
VICE-CHANCELLOR
PROFESSOR COLIN J STIRLING

IN 1966 WHEN FLINDERS UNIVERSITY WAS ESTABLISHED, FOUNDING VICE-CHANCELLOR PROFESSOR PETER KARMEL STATED HIS AMBITIONS FOR THE UNIVERSITY 'WE WANT TO EXPERIMENT, AND EXPERIMENT BRAVELY'. IN THE SPIRIT OF THIS TRADITION, WE RECOGNISE THE 'BRAVE MINDS' OF OUR RESEARCHERS.

JOHN PICKRELL

WHEN INTELLECT WAS BORN

RECONSTRUCTING THE BRAINS OF FOSSIL FISH THAT LIVED 400 MILLION YEARS AGO IS OFFERING PALAEONTOLOGISTS UNPRECEDENTED INSIGHTS INTO THE EARLY EVOLUTION OF OUR OWN BRAINS.

Anything really interesting in the emergence of the human blueprint happened hundreds of millions of years ago, before our ancestors first crawled onto land, says Flinders palaeontologist Professor John Long. That means if we only focus on our recent history to understand our evolution, we're too late to the party.

"Most of the big evolutionary changes between the origin of vertebrates and humans really happened in the fishes before they left the water," he says. "The origin of limbs, jaws, teeth, breathing, sexual copulatory reproduction – all of these things took place in fish, and the rest was just fine-tuning."

This philosophy guides the work of Professor Long's research group, which is trying to unravel how the human body plan was assembled, while also understanding the fundamental evolutionary changes that carried from fish to limbed vertebrates and ultimately to our own species.

To this end, he and Flinders Palaeontology Group colleague Dr Alice Clement have been studying fossils to reconstruct the brains of fish from more than 380 million years ago during the Devonian Period.

"I'm really interested in documenting the changes in the brain and braincase in fish over the water-to-land transition," says Dr Clement. "I want to look at the first tetrapods – or land animals – and their closest fishy relatives to see exactly which changes and features appeared and have then been maintained through to the human brain."

In 2016, Dr Clement and Professor Long published groundbreaking research on the beautifully preserved fossil skull of a lungfish called Rhinodipterus, from the 385-million-year-old Gogo Formation in Western Australia's Kimberley region.

Along with colleagues from Uppsala University in Sweden, Dr Clement pioneered a 'brain-warping' technique, whereby she studied the brains of modern lungfish and used these insights, along with the fossil braincase of Rhinodipterus, to more accurately reconstruct its brain.

This innovation was significant, as fish brains don't fit snugly into the braincase. The resultant gap means fossil braincases alone aren't good guidelines for the shape of the brains that once sat inside them. The technique allowed for a prehistoric brain to be rigorously reconstructed for the first time, using computer models and data from both living animals and fossils.

In May 2018, the pair published a brain reconstruction of a second fish, called Ligulalepis, from 400-million-year-old rocks near Wee Jasper in New South Wales.

Exploring evolutionary changes in these brains could reveal when and why certain senses, such as smell or sight, took precedence and allowed some animals to succeed where others failed. "What's really cool is that you can track changes through evolutionary time," says Dr Clement. "You can see if there are certain regions of the brain that are increasing or decreasing in relative size."

In the lungfish, she noticed a gradual increase in part of the forebrain called the telencephalon, likely related to the sense of smell. "This suggests to me that vision is less important in these fish, perhaps because of the murky water they live in, and that's why they're relying on sense of smell instead."

While the earliest well-established fossils of land-faring limbed fish were found in Greenland and dated to 380 million years ago, Dr Clement says there are other intriguing fossil footprints in Poland that are perhaps 20 million years older. "There are plenty of trackways that are a bit ambiguous, but these ones in Poland have distinct digit impressions, so you can tell there was a foot or a hand."

THE TECHNIQUE ALLOWED FOR A PREHISTORIC BRAIN TO BE RIGOROUSLY RECONSTRUCTED FOR THE FIRST TIME, USING COMPUTER MODELS AND DATA FROM BOTH LIVING ANIMALS AND FOSSILS.

PROFESSOR JOHN LONG

The changes required to walk on land were enormous. "They had to undergo huge structural changes to their vertebral column, ribs, shoulders, and pelvic girdles to suddenly carry this weight and deal with gravity," she says.

Dr Clement expects to also find changes in the brains. Fossil skulls from across the transition show the eyes moving to the top of the head, which is sensible at the water's surface. The eye socket size also increases, suggesting greater reliance on vision, which may prove to be mirrored within the brains in an enlargement of the optic lobe.

"There are just so many questions that arise from this kind of brain reconstruction data. It's a rich source of information," says Professor Long. "We can look at the kinds of changes going across major evolutionary boundaries in early fish."

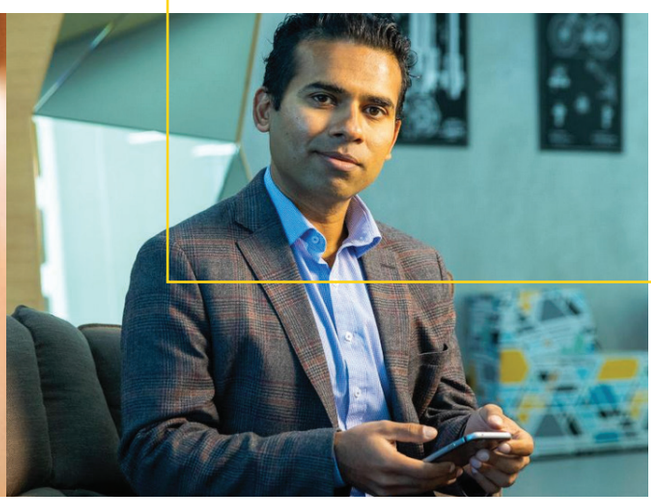
He suspects that they might find changes in the inner ear canals, important for balance. Another brain region they will interrogate is one that is important for sensing light and daylength, and which probably became more important to animals moving onto the land.

Luckily, with several rich Devonian fossil sites in Australia, and Professor Long mounting expeditions to Antarctica to collect similar fossils there, they have plenty to work with.

"I've got beautiful fossils at my disposal," says Dr Clement. "You can't do these sorts of analyses on just any fossil, but we do have quite a few really beautiful three-dimensionally preserved fossils that span the time period, which will really help enlighten how things changed over time."

HANNAH JAMES

THE FUTURE OF HEALTHCARE IS DIGITAL



ASSOCIATE PROFESSOR NIRANJAN BIDARGADDI

Depending on whom you're talking to, the term 'digital health' can arouse either hopes or fears. For some, it evokes images of robotic arms carrying out precision surgery and individually tailored treatments delivered via your smartphone.

For others, it raises fears of government surveillance, health data being sold to the highest bidder, and everyone from your employer to the police knowing when you last contracted a minor infection.

Researchers and clinicians are working to navigate the future challenges and opportunities of using information technology (IT) in the delivery of healthcare, and Flinders is at the forefront.

A recent study led by Associate Professor Niranjan Bidargaddi at the Flinders Digital Health Research Centre used smartwatches and phone apps to correlate users' physical activities with their mental health. If a patient's behaviour seemed unusual – for example, they sat at home all day instead of going out, or they experienced altered sleep patterns – this would trigger an intervention.

"They might not be Facebooking their buddies so much, or they might be sending sombre emails. If you can deduce those things and intervene in time, that's very beneficial," says Professor Anthony Maeder, Co-Director of the Centre and Chair in Digital Health Systems.

One of Professor Maeder's projects is the Flinders Assistant for Memory Enhancement (FAME), which is open to participants aged over 65 who are starting to lose their memory. Combining brain-training exercises, an interactive calendar, and a contacts list, FAME is an iPad app that combats the most common effects of memory loss.

"You can't replace the brain, but you can give people tools to fill the gap that the memory loss is causing – the same as you can give someone who's lost a leg an artificial limb," Professor Maeder explains.

The common theme across these studies is finding new ways to empower patients to help themselves. Flinders cardiologist Professor Derek Chew says this is critical. "The digital revolution is going to democratise medicine, and allow us to build models of care around more accurate clinical decision-making and patient-directed clinical decision-making."

"Healthcare is all about IT," he adds. "It's about getting the right information to the right person to make the right decision. That's where I think the evolution – and revolution – of medicine will be. It's in how we bring more valuable, more precise, more predictive information to the person who is making a decision."

That person could be a doctor, a nurse, or even the patient. With increased precision in tests for imminent heart attacks, along with swifter results and the use of artificial intelligence (AI) in the interpretation of those results, Professor Chew predicts that the one-size-fits-all approach is on its way out.

"The ambulance or GP would get your test results back, and tell you, 'We think you have a less than 1% chance of having a heart attack. Do you still want to go to hospital?' We'll take them to hospital if they want to go, and follow up with those who don't. But it's potentially safer, cheaper care," he says.

At the base of all these applications is data. Data is essential for the AI that Professor Chew's patients will soon depend on for a more accurate diagnosis – the machine learning that can read test results better than junior doctors, and the studies that online tools are based on.

Public trust in the use of that data has a long way to go, but Professors Maeder and Chew believe that education is the key to acceptance, and they're confident that acceptance will come once people see the benefits of electronic health records.

"Digital health technology is already here, and you can deduce better ways to treat subgroups of patients by observing the data on their health condition and their recovery," says Professor Maeder. "You can also deliver interventions by IT to patients, because if the computer knows about them as a patient, then it can customise how it's going to advise them, say, to improve their physical activity."

It's safe to say, the digital future of health is looking increasingly bright.

ROSANNE BARRETT

THE DISCOVERY THAT CHANGED HOW THE WORLD TREATS BOWEL CANCER

PROFESSOR CHRIS KARAPETIS

When Professor Chris Karapetis tested the impact of a cancer gene on a patient's potential treatment for bowel cancer, it overturned the worldwide medication protocol and ushered in a new era of personalised medicine.

Now, as Director of Medical Oncology Clinical Research at Flinders Cancer Research, Professor Karapetis says it was heartening to be involved in a trial with such significant and lasting outcomes. "It's good to feel that what you do has an impact," he says. "This is a piece of work that has a real, tangible end result".

The research led to treatments that give some patients with advanced metastatic bowel cancer an average of six months' longer survival. And, most importantly, their quality of life is also improved.

Even patients who do not respond to this specific treatment see benefits – their clinicians can determine this in advance, sparing them from invasive and expensive interventions.

"This was truly practice-changing," says Professor Karapetis.

The discovery was the result of a worldwide clinical trial, conducted from 2003 to 2006 and coordinated by the Australasian International Gastrointestinal Trials Group. It sought to determine why some patients with advanced bowel cancer were not responding positively to what was otherwise considered a promising new treatment, known as a monoclonal antibody therapy.

Previously, the only proven treatment to extend the lives of advanced bowel cancer patients was chemotherapy, and it was not always effective.

"This treatment was an entirely new class of medicine," says Professor Karapetis.

The new wave of therapies

Antibody drugs, called cetuximab and panitumumab, can inhibit cancer growth by blocking growth signals from a particular type of protein on the surface of the cancer cells. This protein is known as the epidermal growth factors receptor.

These drugs are part of a new wave of personalised medicines that are designed to match the specific patient.

Bowel cancer is Australia's third-most common type of newly diagnosed cancer, with about 17,000 people diagnosed in 2018. Of these, roughly 5,000 will have an advanced metastatic condition, where the cancer has spread to other parts of the body. While 90% of bowel cancers can be treated effectively in the early stages, it remains Australia's second deadliest cancer, as it often goes undetected.

The Flinders team was involved in a clinical trial with 572 advanced bowel cancer patients to determine the effectiveness of cetuximab for those who had already received chemotherapy.

Half of these patients received this new antibody therapy, while the other half received full support without antibody therapy. Professor Karapetis and his team tested whether patients in each group lived longer, if their cancer growth slowed, and what their quality of life was like during the treatment.

The study showed that some patients on cetuximab tolerated the treatment well, lived longer, had improved symptoms and maintained their quality of life. "It demonstrated that this treatment was effective, but we saw that many patients were not benefitting," says Professor Karapetis.

The team wanted to find a way to determine in advance who might benefit, and who might not. They had seen results from other studies suggesting that patients who had a type of bowel cancer with a mutated version of the so-called KRAS gene – part of the cancer's epidermal growth factor receptor pathway – might not respond to the new antibody drugs.

Real-life results

Professor Karapetis led the study that tested the effect of the KRAS mutation on the antibody treatment response.

In 42% of patients, a KRAS mutation was found in the cancer, and in this group, the antibody did not provide any benefit. In the remaining 58% of patients who had the non-mutated KRAS gene, the outcome was more positive. These patients saw a significant increase in their length of survival, from roughly 4.5 months to 10.5 months.

"They've got a greater chance of being alive in six months, a greater chance of being alive in a year, and also a better maintenance of quality of life," says Professor Karapetis.

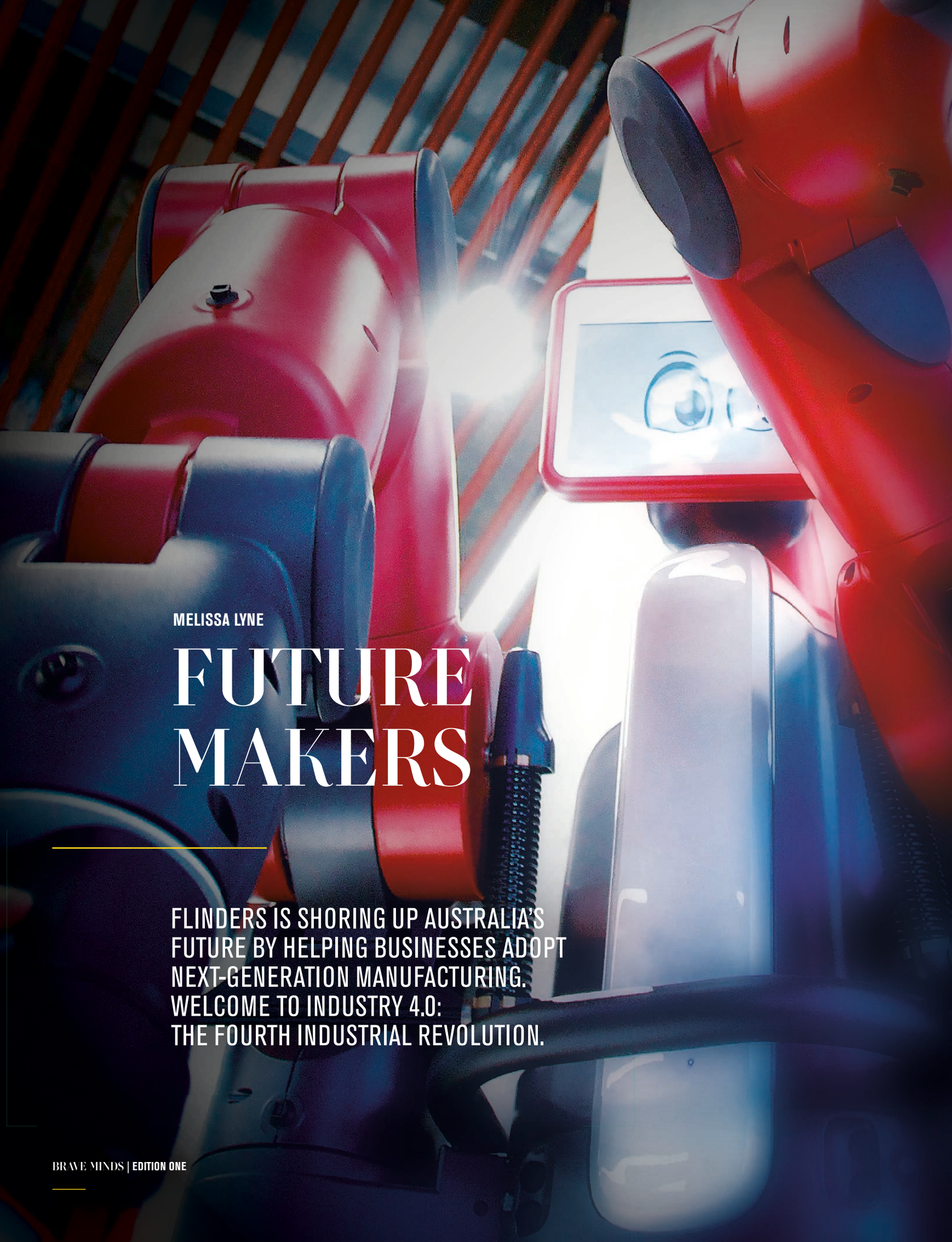
This was the first time in bowel cancer treatment that a biomarker – the KRAS gene – could be used to select therapies and determine the best, most personalised treatment.

After the findings were published in 2008, policy-makers recognised its significance for clinical practice. In 2009, the American Society for Clinical Oncology recommended that patients have their KRAS status tested before receiving antibody therapy that targets the epidermal growth factor receptor.

While the trial has generated significant outcomes for patients themselves, it has also saved health systems around the world millions of dollars. Multiple studies highlighted how KRAS gene testing has avoided unnecessary, expensive treatments for patients who wouldn't have benefited anyway.

Professor Karapetis is encouraged by the trial's outcomes, and urges all Australians to test themselves for bowel cancer. Easy-to-use screening kits are available and free for people over the age of 50.

"This test can save lives," he says.



MELISSA LYNE

FUTURE MAKERS

FLINDERS IS SHORING UP AUSTRALIA'S FUTURE BY HELPING BUSINESSES ADOPT NEXT-GENERATION MANUFACTURING. WELCOME TO INDUSTRY 4.0: THE FOURTH INDUSTRIAL REVOLUTION.

Former president of Mitsubishi Motors Australia Robert McEniry had just one wish for the company's vacated plant at Tonsley. He wanted this manufacturing legacy to once again benefit Adelaide.

In 2015, this vision became a reality when Flinders University moved into its new, $120 million Tonsley campus, alongside a number of other teaching, government, industry, startup, and entrepreneurial bodies.

Operations at the former Mitsubishi site now empower businesses to adopt the next generation of manufacturing – known as Industry 4.0 – for future economic and employment gains.

And, as the business of making stuff continues to rapidly evolve, "no industry will be left untouched," says Pro-Vice Chancellor of Research Impact Professor John Spoehr a leading economic and industry analyst.

The Flinders at Tonsley campus is home to the Australian Industrial Transformation Institute (AITI) and the Tonsley Manufacturing Innovation (TMI) Hub, which are helping South Australia gain a competitive edge over other regions. Global companies such as Siemens, Tesla and Zeiss, also have operations within the precinct.

RATHER THAN DISPLACING JOBS, THESE TECHNOLOGIES INCREASED PRODUCTIVITY AND QUALITY.

"Manufacturing is still fundamentally the most important of the economic sectors," says Dr Mark Dean, a research associate at AITI. "We take it for granted, but everything in the built environment is manufactured."

This means that in order to remain competitive, all manufacturing is under intense pressure to transform using advanced technologies says Professor Spoehr, who led the establishment of the TMI Hub in his other role as the Director of AITI.

The technologies being developed and tested at AITI include robotics, automation, artificial intelligence (AI), nanotechnology, photonics and sensing. The Internet of Things, which creates a network between devices that can 'talk' to one another, is also a focus.

The robot revolution

In early 2018, the TMI Hub launched with the task of investigating an array of advanced technologies.

As companies change the way they make things, being able to test new processes is essential to reducing the risks and costs. The hub's virtual environment setup allows manufacturers to design and test new production processes and technologies well before implementation.

Professor Spoehr explains that implementing new technologies isn't about replacing jobs. Instead, it can introduce a wide range of new manufacturing tasks, while also reducing the risk of physical harm to humans.

"Routine and repetitive tasks are clearly at risk of loss from automation," he says. "But the goal should be to provide more rewarding, highly-skilled, and better paid employment for those impacted. We need to ensure that they share the benefits of Industry 4.0, rather than cut jobs as some companies are doing, which is not sustainable."

With his work stationed in the former Mitsubishi manufacturing plant, Dr Dean says it's inspired him to reflect on the site's industrial past to inform his vision for the future. When in operation, Mitsubishi introduced robots and computer-aided design and manufacturing.

Rather than displacing jobs, these technologies increased productivity and quality.

"We need to use the past as a foundation," he says. "The optimal outcome is to create a future of work that's safe for humans. Businesses can remain innovative by focusing not on how much is manufactured, but on how clever production can be."

Looking to the future

It's no coincidence that some of the world's most developed economies have been built on the back of manufacturing. The progression of society, says Dr Dean, is driven by manufacturing.

PRO-VICE CHANCELLOR OF RESEARCH IMPACT PROFESSOR JOHN SPOEHR

"Other nations have used policy to develop innovative business models and work practices that encourage new forms of production and employment that are aided by technology, not necessarily determined by technology," he explains. "In these nations, robots aren't simply taking jobs, they're changing jobs."

The challenge now is for Australia to significantly scale up the suite of measures already in place and adopt new ones that are capable of achieving change.

Professor Spoehr compares this to what's happening around the world, such as in the UK and other parts of Europe. There, industrial transformation is a high priority and is backed by significant government investment in education and training, research and development, and new facilities.

"This is less about getting technology to businesses, and instead tying it to an overall industrial strategy," says Dr Dean. "This is a place where innovation is able to grow these industries. The companies here compete indirectly but collaborate directly."

As Australia prepares to undergo more challenges in manufacturing in the next 20 years than it has in the past 100, our greatest minds must team up like never before to find new solutions in areas such as medical technology, digital health, renewable energy, and sustainable manufacturing.

As Professor Spoehr says, "Here at Tonsley, we are creating the foundation for the country to accelerate the growth of manufacturing businesses, as well as rewarding jobs."

BILL CONDIE

NAILED IT!

DETECTIVE WORK BY A LEADING FLINDERS MARITIME ARCHAEOLOGIST IS REVEALING THE SECRETS OF A SHIP FROM ANCIENT GREECE. AND AT THE HEART OF IT ALL ARE SOME HUMBLE COPPER NAILS.

All it took was a handful of nails and a few scraps of timber from the muddy seafloor off the coast of Turkey for maritime archaeologist Associate Professor Wendy van Duivenvoorde to build a fascinating picture of shipbuilding 2,500 years ago.

"You take all the clues into consideration. It's a bit like a crime scene," she says of the analysis she carried out on the remains of the Ancient Greek shipwreck at Tektas Burnu in western Turkey. "You have to look at all the components as part of the investigation."

According to Associate Professor van Duivenvoorde, the nails offer a sense of how the vessel was built and how large it was, "and then, in conjunction with the cargo that was found on that particular ship, you gain an understanding of the whole civilisation at the time," she says.

The Tektas Burnu ship sank in about 45 metres of water between 440 and 425 BCE. Despite almost nothing being left of the soft pine timbers that once made up the hull, the find was important, giving a new understanding of craftsmanship at the height of the Athenian maritime empire.

“THE SHIPBUILDERS WOULD DRILL A HOLE THROUGH THE PLANKING AND THE FRAME, AND SEAL THAT WITH A WOODEN PLUG. THEY’D THEN DRIVE THE NAIL THROUGH INTO THE DIRECTION OF THE GRAIN.”

The find also produced the only examples of marble *ophthalmoi* – the ship’s eyes – from an ancient shipwreck. It’s believed that these ‘eyes’ served a combined role as navigation aids and to ward off evil.

While it was already known that these features existed, experts assumed that they were painted on. “It was always thought that marble was too valuable to put on the bow of a ship, and that they were probably painted on or ceramic,” says Associate Professor van Duivenvoorde.

One hundred-odd copper nails and fragments of timber around them were found at the site, providing major clues as to the ship’s provenance.

“We know those nails were used for attaching the frames to the planking, because they built ships with shell-based construction methods at the time – not with a plank on a frame, as we would today if we were to build a wooden ship,” Associate Professor van Duivenvoorde explains.

‘Mortise-and-tenon’ joints were used to connect the planks, which hold everything together via the insertion of a rectangular piece of wood into opposing holes between two planks. The piece of the wood is called the tenon, and the holes in the planks are called the mortises. Once the ship’s hull, or ‘shell’, was assembled, pine frames were added for internal strengthening.

“The shipbuilders would drill a hole through the planking and the frame, and seal that with a wooden plug. They’d then drive the nail through into the direction of the grain,” says Associate Professor van Duivenvoorde. “We tested that, and it works quite well.”

Each nail was itself something of a work of art, she adds. “They’re not cast nails, they’re each individually hammered. They’re beautiful; the level of craftsmanship is something we don’t see today anymore.”

And they were practical, too. “Due to hammering, they become stronger. You hammer them, you heat them, and then you hammer them and heat them again. That can increase the strength of copper by 400 to 500%.”

There were likely no time restrictions in terms of the shipbuilding in Ancient Greece, says Associate Professor van Duivenvoorde, because wealthy people would pay for ships to be built. “They had a lot of slaves, so time was not an issue,” she adds.

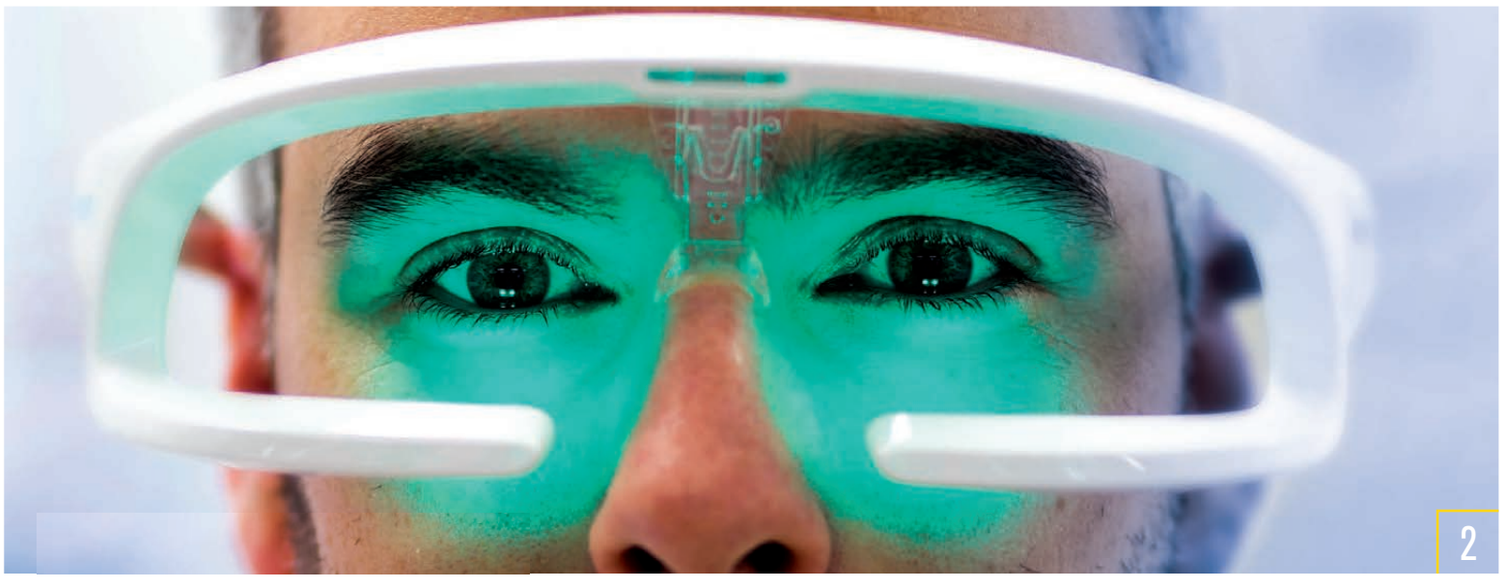
While she can’t say for sure where the ship was built, she did locate where the copper was mined, tracing it to an area in Cyprus. “Of course, that doesn’t mean that the ship was built there, and we know that a lot of ancient copper was mined on the island of Cyprus,” she says.

The trees that provided the timber don’t help archaeologists narrow down the shipyard’s location either, being from a type of pine and oak that was then found throughout the region around the Aegean Sea. “We think it was built somewhere along the Turkish coast, or the Aegean Turkish coast, but we don’t know 100% for certain,” she adds.

It’s only fitting that a shipwreck discovery of this magnitude keeps a few more secrets up its sleeve.

Top to bottom: copper frame nail, under side of one of the marble *ophthalmoi* showing the lead fastener, cross-section of frame nail.

ASSOCIATE PROFESSOR
WENDY VAN DUIVENVOORDE



JOHN PICKRELL

5 REVOLUTIONARY MEDICAL TECHNOLOGIES THAT ARE CHANGING LIVES

FLINDERS' INNOVATIVE MEDICAL DEVICE PARTNERING PROGRAM IS OVERSEEING THE RAPID DEVELOPMENT OF A SLEW OF FUTURISTIC HEALTHCARE TECHNOLOGIES.

The Medical Device Partnering Program (MDPP) at Flinders University is an 'ideas incubator', which takes great concepts for new medical technology and finds the right mix of clinicians, academics and manufacturers to turn them into real products.

"We identify six to eight ideas a year that have the most potential to make a difference," says MDPP Director and biomedical engineer Professor Karen Reynolds.

The program launched 10 years ago, when Professor Reynolds was becoming frustrated that new medical inventions "would end up sitting in the lab, not going anywhere".

So, she created a 'one-stop-shop', bringing together inventors, end-users, medical researchers, clinicians and small companies to connect the dots and smooth the journey of exciting tech to market. Here's a selection of the MDPP's biggest successes.

1

MAXM SKATE

To recover from a knee replacement, patients must perform rehabilitation exercises. But orthopaedic surgeon Dr Matthew Liptak noticed that some of his patients weren't recovering as quickly as others. The problem was that they weren't sticking to their motion and strengthening exercises.

The solution he invented was the Maxm Skate – a roller-skate-like device that straps to the foot, easing movement. The MDPP helped him develop sensors that measure the angles of the user's knee inside the device, which is sent to both the user's smartphone and their clinician for monitoring.

Enabling patients to track their progress has been a great motivational tool to encourage perseverance, Dr Liptak found. The Maxm Skate is now being tested in clinical trials.

Learn more at www.maxmskate.com.au

2

LIGHT THERAPY GLASSES, RE-TIMER

Flinders sleep psychologists Emeritus Professor Leon Lack and Dr Helen Wright study the effect of light on our daily rhythms. They realised that exposure to specific kinds of blue-green light could be useful for reducing jetlag and treating both insomnia and a type of depression called seasonal affective disorder, as it stimulates the production of melatonin – a hormone that controls circadian rhythms. The MDPP helped the pair develop prototype light-therapy glasses.

"The glasses work by shining light onto the back of your retina, and readjust your body clock," Professor Reynolds explains. The prototype was enough to convince investors of its value, and the Re-Timer Glasses are now on the market. They retail for $299, are available in 40 countries, and are used by sports teams such as the Socceroos.

Learn more at www.re-timer.com

3

EZY-AIM DISTAL TARGETING DEVICE, AUSTOFIX

To fix fractures, surgeons sometimes need to insert a pin into the centre of a limb bone. "The trouble is, they're never exactly sure where the end is, and they need to put a screw through to hold it in place," says Professor Reynolds.

To line things up, they must take a series of X-rays, exposing patients to radiation. As an alternative, Adelaide-based company Austofix invented a device that allows surgeons to identify where the end of the pin is, and where the anchoring screw must be inserted.

The MDPP collaborated with end-users to design and create a prototype of this device. Surgeons have lauded the product – now sold in 13 countries – for being easy to use, and the MDPP and Austofix are now working on a second-generation Ezy-Aim that is controlled using a smartphone or tablet.

Learn more at www.austofix.com.au

4

CAS SPLINT

When director of Fluoro Medical Scott Blackburn broke both arms and a leg, he was stunned that paramedics used simple pieces of cardboard to immobilise his limbs. This inspired him to invent the easy-to-use CAS Splint.

"If somebody's got a suspected fracture, it's very easy to assemble, enabling you to quickly keep the limb immobile," says Professor Reynolds. The splint is cheap, waterproof, fits into a standard first-aid kit, and doesn't need to be removed during X-rays. It's also disposable or reusable. The MDPP helped Blackburn perfect the device by testing it with end-users and providing vital design modifications. The CAS Splint retails for $24.90.

Learn more at www.fluoromedical.com

5

CANCER MARGIN DETECTION PROBE

When doctors perform breast-cancer surgery, it can be difficult to determine if they've removed all the affected cells. "The only way of knowing is to take a small tissue sample and look at the margins," says Professor Reynolds. "If they haven't got it all, the patient has to come back for follow-up surgery."

Dr Erik Schartner and Professor Mark Hutchinson from the University of Adelaide wanted a more efficient solution, so they invented the Cancer Margin Detection Probe, which recognises cancerous tissue by its pH levels. This means that surgeons can find the edges of the tumour during surgery, removing the need for additional procedures.

The MDPP assembled a team, including doctors, mathematicians and biomedical engineers, to build a prototype probe and demonstrate its function in an operating theatre. That allowed Dr Schartner and Professor Hutchinson to attract significant funding for further development.

Watch this space.

Learn more at mdpp.org.au

JOHN PICKRELL

PAST PERSPECTIVES FROM A PIONEER

A discovery that came from Dr Chris Wilson's decade-long study of 100 shell midden sites along the Murray River is so significant, the National Museum of Australia (NMA) is clamouring to include it in an upcoming exhibit.

The 35-year-old Ngarrindjeri man – who in 2017 became the first Aboriginal Australian to earn a PhD in archaeology – discovered an 'otolith', or fish ear bone, from a Murray cod among a wealth of evidence captured in these midden sites. The sites tell of a thriving Ngarrindjeri community that has been hunting and foraging in the area for at least 8,500 years.

Murray cod today are no more than 1.8 m in length, but the size of the otolith Dr Wilson found suggests a fish at least 2.2 m long. "It's good evidence that the river system at that time, 5,000 years ago, was healthy enough to have fish of great size and age," he says.

Now a senior lecturer in the Flinders College of Humanities, Arts and Social Sciences, he's seeking Ngarrindjeri community permission for the otolith to be displayed in an NMA environmental histories exhibition in 2020.

In demand for his Indigenous perspective and archaeological expertise, Dr Wilson is also working with the South Australian Maritime Museum on the involvement of Aboriginal peoples in whaling and sealing.

He recently uncovered an unexpected link to his own family history as part of that research. "My family has a strong connection to whales, so I want to explore that further," he says.

Dr Wilson hopes to engage Ngarrindjeri more widely in their heritage, and as Indigenous liaison officer of the Australian Archaeological Association, he wants to encourage greater Indigenous involvement Australia-wide in Aboriginal and Torres Strait Islander heritage. One focus is inspiring students to undertake postgraduate and undergraduate degrees.

"There are people out on country who do this kind of work, but they are not formally qualified," he says. "I want to engage with colleagues about how we might encourage young people to get those qualifications."

He is also a chief investigator with the National Indigenous Research and Knowledges Network, which includes members from 50 Aboriginal nations and 21 universities. Its goal is to swell the ranks of highly skilled and qualified Aboriginal and Torres Strait Islander researchers.

In addition to these many projects, Dr Wilson continues to be involved with repatriating Aboriginal remains to Ngarrindjeri land, and has even been asked to collaborate with a French string quartet on a composition involving Ngarrindjeri themes.

"I've been asked by a lot of colleagues to get involved with projects," says Dr Wilson, who has some busy years ahead.

DR WILSON HOPES TO ENGAGE NGARRINDJERI MORE WIDELY IN THEIR HERITAGE, AND AS INDIGENOUS LIAISON OFFICER OF THE AUSTRALIAN ARCHAEOLOGICAL ASSOCIATION.

DR CHRIS WILSON

LAETITIA LAUBSCHER

THE CHANGING FACE OF GLOBAL SECURITY

Professor Andrew Goldsmith started investigating transnational crime more than two decades ago, after having witnessed first-hand the impact of the drug war in Colombia.

He'd been invited to the South American nation after members of the Colombian Ministry of Defence read his book, Complaints Against the Police: The Trend to External Review, and invited him to assist in their police reform process.

Many of the events now portrayed in the Netflix hit Narcos occurred while Professor Goldsmith was in Colombia. He met the real Attorney-General Pablo de Greiff and Rosso José Serrano, who became the General of the National Police and a fundamental player in dismantling the notorious Cali Cartel.

When on the frontline in Colombia, Professor Goldsmith realised that more research was needed on transnational crime, which was a relatively underappreciated criminal activity at the time. "You can't talk about police reform in a country like Colombia without reckoning with the enormous distraction of, and effort involved in, fighting the drug war," he says.

The former lawyer is now considered a leading expert in the field. As Strategic Professor in Criminal Justice and Director of the Centre for Crime Policy and Research at Flinders University, he is also co-editor of the Australian and New Zealand Journal of Criminology, and has authored numerous journal articles, reports, chapters and books on the subject.

While transnational crime is keeping Professor Goldsmith busy today, the concept is a relatively new one in terms of how governments around the world are dealing with it.

The United States first recognised transnational crime in the mid-1970s, but it wasn't until 1995 – around the time that Professor Goldsmith was in Colombia – that the UN issued its official definition as "offences whose inception, prevention, and/or direct or indirect effects involved more than one country". It identified 18 categories of transnational crime, including human, drug and arms trafficking.

Since 1995, transnational crime has grown exponentially, spurred on by globalisation, communication and mass migration. The cost of transnational organised crime is estimated to be about 3.6% of the global economy, with about 20% of that coming from the illicit drug trade.

"The global demand for recreational drugs has had an extraordinary impact on criminality and law enforcement, and the scale of criminality in countries across the globe," says Professor Goldsmith.

There are two major challenges in tackling transnational crime: bureaucratic issues, such as the division of responsibility between agencies in different jurisdictions and even within the same jurisdiction; and the effects of cyberspace, which make tackling transnational crime particularly difficult.

"The evolution of the internet – social media technologies, encryption technologies, digital banking technologies – have all created new pathways, new skill sets, new opportunities," says Professor Goldsmith.

This has led to the emergence of new types of criminals, as well as new criminal methods, such as the Mafia using encryption technologies to conceal their communications from law enforcement.

The current model now used to combat transnational crime is not entirely fit for purpose, even when there are successful arrests and prosecutions.

"The big investment is in law enforcement – the attempt to deter and prosecute offenders," says Professor Goldsmith. "But it hasn't stopped the rapid replacement of those openings by other groups. Police increasingly say that in some of these areas, 'We can't arrest our way out of these problems.'"

Research efforts by Professor Goldsmith and others are key to analysing both the efficacy of the current enforcement measures taken, and to understand the drivers and underlying causes of the crimes themselves. The hope is that, with better understanding, we can address the issues in a more holistic and preventative way.

Flinders is now running a longitudinal study on the role of the internet in recruiting adolescents into crime, as well as an interview-based study looking at offenders' relationships with guns.

The insights will be crucial for Australia in its efforts to enhance global security, while also protecting Australian communities.

"There's a lot that's going on offshore that we don't consider or appreciate enough, but that's the case equally at home," says Professor Goldsmith.

"Ice is brought from China into Australia and sold by motorcycle gangs, or distributed by them across rural and regional Australia. The effects on families as well as individuals is quite striking. There's a connection between harmful things in our own backyard and transnational crime."

PROFESSOR ANDREW GOLDSMITH

TRANSNATIONAL CRIME HAS GROWN EXPONENTIALLY, THANKS TO GLOBALISATION, THE BOOMING ILLICIT DRUG TRADE AND THE EMERGENCE OF NEW CYBERTECHNOLOGY.

“THE AIM IS TO CREATE AUTONOMOUS VEHICLES, PARTICULARLY UNDERWATER VEHICLES, THAT CAN ACTUALLY THINK FOR THEMSELVES, NOT JUST OBEY INSTRUCTIONS.”

Pictured: Professor Karl Sammut

NICK CARNE

GOING DEEP

DRIVERLESS CARS MAY HAVE CAPTURED OUR IMAGINATION, BUT AUTONOMOUS MARINE VEHICLES HAVE EVEN BIGGER POTENTIAL FOR CHANGE, BOTH ABOVE AND BELOW THE WATERLINE.

Imagine being able to watch over Australia's vast coastline, map the ocean floor, monitor fish farms and dive deep to repair a subsea oil rig – all without putting anyone to sea, let alone in danger.

As Director of the Flinders Centre for Maritime Engineering, Control and Imaging, Professor Karl Sammut and his team are developing the technologies to make this a reality.

"The aim is to create autonomous vehicles, particularly underwater vehicles, that can actually think for themselves, not just obey instructions," he says.

"Basic mission planning is relatively easy, but once you start developing a vehicle that can sense and understand environmental conditions and be able to develop and change its own mission plans, the planning becomes more complex. We have to be able to rely on what it has decided, so we can know that it's going to make a good decision and come back safely."

It's an area that's fascinated Professor Sammut for more than a decade, but in the early days it was difficult to get traction in Australia. Funding agencies understood the value from a defence perspective, but failed to see the real potential of these 'smart' boats and submersibles.

Fortunately, attitudes are changing, and Flinders is one of the leading universities in Australia involved in maximising this potential. Professor Sammut's team is funded by both state and federal agencies, and is collaborating with national and international companies on major Australian defence projects.

He identifies three key factors for success when building an autonomous underwater vehicle (AUV) that works just as well – or even better – than its human counterparts.

The first is autonomy. AUVs have one major advantage over driverless cars in that there are fewer things to collide with – notably people. But at the same time, there are also no designated routes (i.e. roads) to follow and, more problematically, GPS and wi-fi don't work underwater. This means you have to find alternative ways to provide guidance, so the vehicle can figure out where it is and where it's heading.

This brings us to the second key component: communication back the other way, so the vehicle can reliably and continuously transmit data.

"By its very nature the communications system underwater is poor," says Professor Sammut. "We can only communicate with a vehicle using an acoustic modem, which has the same bandwidth as the old telephone modems. You're never going to be able to send video back, so you have no idea what the vehicle is 'seeing'."

"You can use sonar, but then the vehicle needs to be able to interpret what it's seeing and make sense of it," he adds. "So that's where all the research is in terms of adding in artificial intelligence: the capability to understand what it sees, then make decisions."

The third component is mission guidance, including navigation and control, which is an area of focus for the Flinders team. The key here is to build a vehicle that can move on its own both safely and with purpose.

"You have a map of the area. You have some knowledge of the currents and other things happening, and you give these to the vehicle so it can come up with its own mission plan," Professor Sammut explains. "Then you might say you want it to do certain tasks, but how much fuel does it have? How much will it consume to go against the current? It has to work out how many of its tasks it can achieve."

Conditions can change dynamically underwater, which means the vehicle has to be able to decide for itself what it's going to do and how to come back safely.

The big challenge now is to develop vehicles that have enough endurance to stay submerged long enough do useful work, because at some point, their batteries will run low. Developing docking stations where AUVs can recharge by themselves – and the autonomous guidance systems that enable them to dock – is one of the main research activities at Flinders.

The ultimate aim for Professor Sammut and his team is to develop vehicles that can get work done unassisted. So, rather than having a submarine-welding robot controlled via cable by a human on the surface, the vehicle has the smarts to do the welding itself.

Research is already underway in this and many other areas, and it's anyone's guess as to what's coming up next.

"We haven't even started to discover how far we can go with these things," says Professor Sammut. "The technology has changed rapidly in terms of sensors and battery capability. The horizon is rapidly expanding for these kinds of potential applications."

NICK CARNE

CLEAN, GREEN CHEMICAL CRUSADER

MEET THE PIONEERING PROFESSOR WHO'S HELPING INDUSTRIES SWITCH TO CHEAP, ENVIRONMENTALLY FRIENDLY TECHNOLOGIES TO REDUCE ENERGY USE AND WASTE.

Professor Colin Raston and his colleagues made international headlines in 2015 when they proved the impossible was possible – you can, in fact, unboil an egg.

But Professor Raston reckons he's done even better work since. That's not an idle boast, it's just a reflection of how important and valuable this 'unboiling' technology is, and will continue to be, for many different industries.

The Vortex Fluid Device (VFD) he invented to pass the time on a 15-hour flight has revolutionised flow chemistry, in which chemical processes occur in a continuous flowing stream. The VFD can rapidly create a range of chemicals in water and other non-toxic liquids, significantly reducing the cost and environmental harm in a range of chemical processes.

It looks and is deceptively simple to use. All you see is a tube that spins at very high speeds and at a variety of angles – but it has created a new paradigm for how things are done in the chemical and biological sciences, as well as materials processing.

"You can make complex organic molecules. You can use it for drug delivery, for making tools for imaging. It covers food processing, we've got projects going in wine processing, and I'm just going through the first paper on fish oil encapsulation at nanometre dimensions," says Professor Raston.

"We can use it to cut carbon nanotubes without using chemicals, exfoliate graphene from graphite without chemicals, and to make graphene oxide with zero waste – which is a big deal," he adds.

Using it to unboil an egg – by refolding the proteins into the state found prior to cooking – was a nice bit of theatre, and not surprisingly won an international Ig Nobel Prize in 2015. As the Ig Nobels describe themselves, they aren't about crazy or pointless science, but about "honouring achievements that make people laugh, then think". And Professor Raston has been making people think over his whole career.

The VFD brings together his two passions: scientific innovation and green chemistry. For more than 20 years he's been championing the importance of chemists developing products and technologies that don't create large amounts of waste or require unnecessary energy in their production. "Green chemistry is all about reducing the negative impact on the environment," he says.

In the early days, there were many cynics who doubted the value of spending time and effort on developing more sustainable chemical practices. "I thought, at one stage, my career was going to go down the gurgler," Professor Raston admits. "But the younger generation were saying 'Why haven't we been told about green chemistry before, where can we find out more information?'"

"WHY HAVEN'T WE BEEN TOLD ABOUT GREEN CHEMISTRY BEFORE, WHERE CAN WE FIND OUT MORE INFORMATION?"

It was this that encouraged him to persevere.

Fortunately, Professor Raston found some like-minded souls to work with. In 1991, two scientists from the US's Environmental Protection Agency (EPA) released their *12 Principles of Green Chemistry*. They then invited him to represent Australia at a high-powered roundtable meeting in Washington, DC in 1998, which was designed to get people thinking.

Since then, more sustainable chemical practices have become not just a reality, but the accepted norm, required in most grant applications. Professor Raston says that nearly everyone who attended the roundtable in the US has since been honoured by their governments for their contributions to the industry. He was appointed an Officer of the Order of Australia (AO) in 2016.

"It's all happened in the last couple of years," he says. "Now there are lots of international conferences."

Most significantly, it's shifted the mindset, he says, particularly with the younger generation of scientists. Whereas in the past, a chemist might have used a highly toxic organomercury compound to solve a problem, now they'd think twice. "They'd say, 'Hang on, as chemists we're supposed to be able to come up with alternatives,'" he says.

For Professor Raston, a focus since moving from the University of Western Australia to the Flinders College of Science and Engineering in 2013 has been scalability: how he can scale up green processes developed in the lab to an industrial level.

His lab has already published more than 60 papers on the use of the VFD, and is collaborating with other universities in Australia, the US and Europe. It has two joint patents with the University of California, Irvine, focused on the multi-billion-dollar pharmaceuticals industry, not to mention a number of other patents, too.

Things are now moving rapidly. In June 2018, Flinders University and ASX-listed company First Graphene formed 2D Fluidics – a business that will both produce environmentally safe supplies of high-grade graphite and make the VFD technology commercially available.

"It's easy to use – just plug and play," says Professor Raston.

TRUST IN AN ERA OF FAKES

A NEW FLINDERS RESEARCH CENTRE IS SETTING OUT TO REBUILD DEMOCRATIC VALUES

Flinders University has launched an innovative new research centre designed to shore up trust in democratic values in an era of disinformation, deep fakes and compromised electoral campaigns.

The Jeff Bleich Centre for the US Alliance in Digital Technology, Security and Governance (JBC) is named for a former US Ambassador to Australia, who is patron of the project and will play an ongoing role in its operation and development.

"It will focus on restoring trust and integrity in the digital age," says Ambassador Bleich, adding that the alliances that built the international liberal world order need to adapt to these new technologies. "Our freedom and our security depend on it."

While technology holds the promise of universal access to information, it has also emerged as a powerful disruptive force according to Professor Don DeBats, Head of American Studies at Flinders University.

"And the consequences of this have been frightening," he says.

"It is so easy when there has been rapid technological change for trust to be eroded, for people not to trust one another, to not trust people who are somewhat different from them.

"Our ideological opponents have seen that weakness – and they have acted – and the consequences are disruptive and destructive for democratic societies and the values that we hold."

The centre's work will seek solutions to this and to chart a course for the future.

"We cannot again allow technological change to outpace our answers to technological change," says Professor DeBats.

"We cannot leave people behind who are vulnerable and who are frightened, not just for themselves but for their children.

"And that is the most important mission of this centre."

Jeff Bleich, who is now based in San Francisco, was appointed as ambassador to Australia by President Obama in 2009 and held the post through 2013. He is a longstanding friend of Flinders and received an honorary doctorate from the University in March, 2014.

Ambassador Bleich, who is also chairman of the Fulbright Foreign Scholarship Board in the US, draws on history to explain why he agreed to help establish the JBC.

"It's not just a matter of learning the lessons of history, but also acting now to protect future generations. Every massive technological disruption has created an opportunity in the short-term to exploit others. But doing that inevitably imperils long-term peace, and has always produced wars, economic collapse and failure. The people who built the international liberal order were willing to make sacrifices, and act in a far-sighted way; rebuilding their adversaries, developing trustworthy markets, forging agreements about dangerous technologies and fashioning a rules-based order."

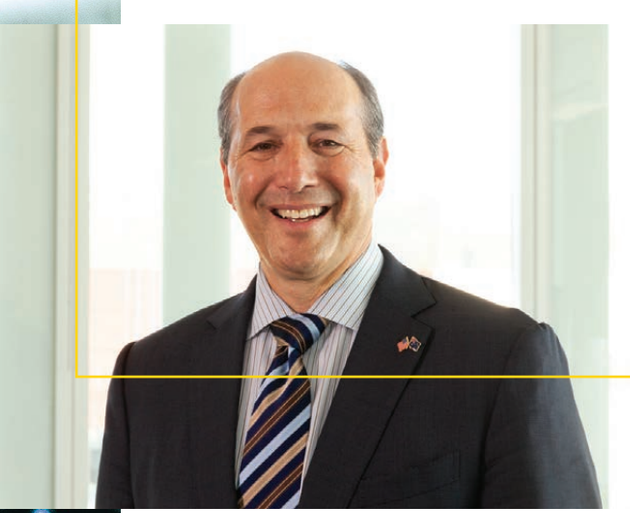
"I think the lesson from history is not just 'don't make the same mistakes' but, make the choice now to sacrifice and serve for the next generation," he says.

"My other big lesson at Flinders is that when Don has a vision, don't stand in the way of it, just go along for the ride."

The initial focus of the JBC will be the analysis of the strategic social science implications of new technologies with respect to the Australia-United States defence and security relationship.

In this, the centre will capitalise on the existing collaborative relationship with the Defence Science and Technology group (DST) in cyber research projects, and it will extend Flinders' social science research capacity in blockchain applications to defence.

JEFFREY BLEICH



“IT’S NOT JUST A MATTER OF LEARNING THE LESSONS OF HISTORY, BUT ALSO ACTING NOW TO PROTECT FUTURE GENERATIONS. EVERY MASSIVE TECHNOLOGICAL DISRUPTION HAS CREATED AN OPPORTUNITY IN THE SHORT TERM TO EXPLOIT OTHERS.”

The research program will work with the major defence initiatives being developed in South Australia as well as major industry players with a large investment in the future of security – Australian banks, and legal, data and ICT companies, both in Australia and in California.

Ambassador Bleich’s Californian link and close ties to initiatives in the US state around cyber research and security (including water security) will not only benefit the JBC, but also the National Centre for Ground Water Research and Training based at Flinders, and South Australia’s collaborative Goyder Institute for Water Research. These ties will also help to extend Flinders’ strengths in autonomous vehicles and AI start-ups, and assist in expanding Flinders’ international collaboration with California universities, companies and institutes.

Professor DeBats says it is an opportunity for Flinders to continue to fulfil what it set out to do 50 years ago as a “new and innovative university”. The centre combines strengths in the social sciences with those of technology.

“We have an exciting, creative program that brings together some of the strengths of Flinders University,” Professor DeBats says.

“And we hope that the young people who will take over this relationship between the United States and Australia will benefit from this kind of perspective.”

Because, he says, the ‘problem space’ is not unique to one country or the other, “it is one we share and perhaps there is a ‘solution space’ that we can both share”.

But in order to flourish, not just from a funding perspective, Ambassador Bleich says all stakeholders must become engaged.

“Right now the biggest challenge is not simply for the government to act,” he says, “but for business and the government to act together and offer a positive vision for the future. The public will not trust government or tech until they see everyone at the table together working toward the common good.”

“The best things we have ever built in society – including my home town of Silicon Valley – have not come from just one sector; they’ve come from the public sector and the private sector and the not-for-profit sector and the research sector, all coming together to try and solve a problem.”

Professor DeBats believes the JBC has a good chance of achieving that.

“We need to anticipate change and prepare our society, our people and the children for a changed future so they are not afraid of it but embrace it, enjoy it, and see the opportunity, not a threat.

“In that confident space they can trust one another and not be divided.”

HANNAH JAMES

THE WILDLY POPULAR PROJECT THAT'S DEMYSTIFYING DEATH

It's guaranteed to happen to every single one of us, but talking about death doesn't come easily to the average Australian. A Flinders University project is helping to change all that.

CareSearch is a world-first resource designed to educate health professionals about palliative care, as well as members of the public, including caregivers, patients and their families. "It's evidence-based – that's really important," says Director, Professor Jenifer Tieman.

In the 10 years since its launch, CareSearch has grown far beyond a simple informational resource. It now attracts 100,000 visitors per month, and with thousands downloading its apps and completing its Dying2Learn MOOC (or Massive Open Online Course), it's reached far beyond the palliative care community and into the world of the healthy and curious.

Professor Tieman has a few ideas about how it came to be such a runaway success.

"First, the way our society deals with death and dying has undergone a major change of late, given our ageing population and the fact that more people are living with chronic, progressive diseases. This means Australians are more likely to want – and need – to engage with content around the topic."

"In addition, if we look back centuries ago, death primarily happened at home. But during the 20th century, death was rapidly outsourced to hospitals."

"One or two generations ago, people were dying earlier from disease or in wars, and it was much more visible in the community and to families," Professor Tieman explains. "Much of that context has now gone, because we've had such success with medical intervention. And so we're having to rediscover dying in a different way."

This is crucial, she adds, when we consider Australia's ageing population. Rather than being solely a family responsibility, caring for the elderly is now falling to government and private services, as adult children are becoming more geographically mobile, and families with two working parents are becoming the norm, meaning they have less time to devote to care.

With this shift from a private, family matter to something often reliant on community assistance, Australians are becoming more open about the whole process of ageing and dying.

"In the past four or five years, it's become more normal to talk about death and dying in Australia, because it's affecting more people within the community," says Professor Tieman. "There are death cafés, where people get together over a cup of tea and share their stories; there are online courses building death literacy; and the Groundswell project even hosts an annual 'Dying to Know Day'. This suggests we are creating new rituals and new understandings as a community around death and dying."

CAN WE GET BACK TO BEING COMFORTABLE WITH DYING IN OUR OWN HOMES?

The second factor Professor Tieman cites for the success of CareSearch is its ease of access. Being online, it's accessible 24/7, which is important considering sickness and death don't keep office hours.

The project is technologically innovative, too, and continually evolving.

"We're already figuring out how to incorporate chatbots, and how to use the power of technology to create better access with, say, voice-activated software," says Professor Tieman. "We're looking at how we can maintain the quality of the information and its trustworthiness, using these expanding options."

It's hoped that with more open conversations about ageing and death, and a greater understanding of how we respond to it, CareSearch can help answer bigger-picture questions such as, can we get back to being comfortable with dying in our own homes?

"A lot of dying is occurring in hospitals, with interventions almost up to the point of death," says Professor Tieman. "The question becomes, 'How has this happened? Would normalising dying have allowed that person to die spending time with their family, rather than in hospital beds?'"

The success of CareSearch has attracted plenty of attention, with support and funding from the Australian Government and a range of partnerships such as with End of Life Directions for Aged Care (ELDAC), which connects people from palliative care, aged care and primary care.

It's also enabled the Flinders team to further expand into aged care with palliAGED – another online resource, which provides palliative care evidence to the aged care community and apps for GPs and nurses. These technologies place Flinders University at the forefront of the issue in Australia.

PROFESSOR JENNIFER TIEMAN

JOHN PICKRELL

THE HOME THAT LOOKS OUT FOR YOU

By 2050, people aged over 80 will make up more than 9% of the population in developed nations, compared with less than 4% now. The obvious question is how our societies will look after them all.

The obvious answer is to have their homes pick up some of the slack say Professors Trish Williams and Anthony Maeder, who hope to have a prototype 'smart home' up and running within five years.

The pair moved from different parts of Australia to Adelaide in 2016 to set up and co-lead the Flinders Digital Health Research Centre, an exciting multidisciplinary initiative to create Australia's first healthcare smart home. The teams they lead are creating what they describe as "intelligent assistive environments", embedded in the fabric of our houses and apartments.

"The concept is that your home pays attention to your health and wellbeing, measuring or observing aspects of your daily life relevant to health," Professor Maeder explains. This might be useful if you're at risk of falling, or a diabetic whose blood sugar level fluctuates – the house can keep an eye on you, reporting unusual behaviours or flagging an alert.

In essence, he says, a smart home observes what you're doing throughout the day to make sure you're okay. "If you're an older person living alone, there's a tendency sometimes to skip meals or be inactive. The health-smart home would take note and suggest you take action."

As well as embedded cameras and movement detectors, the kinds of sensors required might include wearable heart and blood-sugar monitors. There could even be data coming from the stove, fridge, shower or sink.

Smart homes might also have conversational avatars and chatbots that act in place of humans for simple tasks, or even just interact to make you feel less lonely. They might also have smart walls – video screens that seamlessly connect you with distant relatives or social networks.

Devices such as Google Home and Amazon Alexa already recognise voices and obey basic commands. "The question is, how do we make it work in a healthcare setting, as opposed to online shopping, or showing you a movie? Those sorts of requests are much more specific," says Professor Maeder.

While devices already exist to monitor seniors' health – such as wearable sensors that detect a fall – they are nearly all standalone technologies that can't integrate into a larger intelligent system. This is what Professors Maeder and Williams' teams are focusing on.

While Professor Williams' expertise lies in software, cybersecurity, health informatics and developing IT solutions, Professor Maeder's experience lies in engineering as it relates to nursing and healthcare. "We complement each other well because Trish has a really strong systems theme, and I have a very strong technical bits-and-pieces focus," he says.

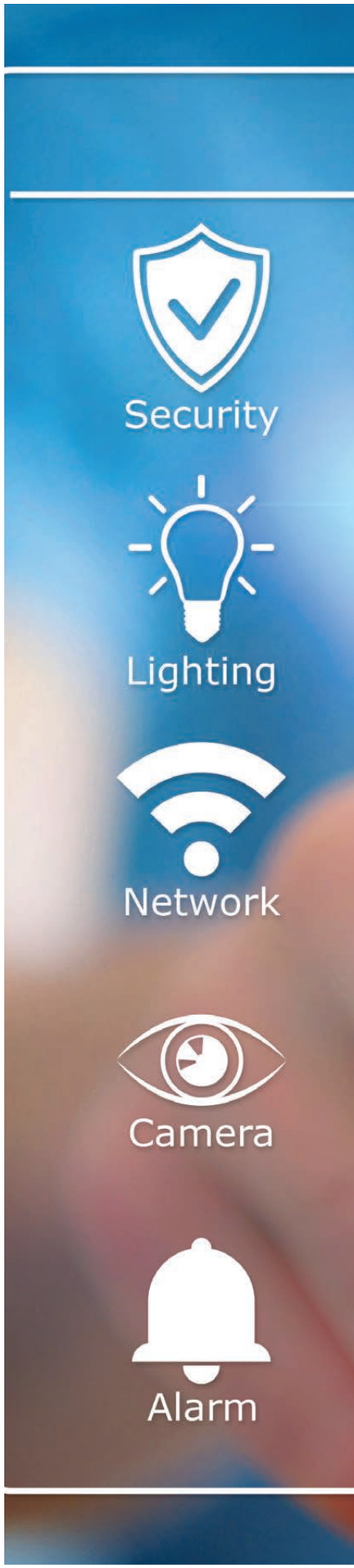
The pair are working to create an intelligent overall surveillance system that can intervene to prevent problems before they occur. Processing this data would be automated in real-time, looking for any warning signs to flag with a human operator or carer.

"But how can you visualise the data in a way that technicians or health people can look at it and say, 'What does this mean?' and decide what to do to help?" asks Professor Williams, whose team is now trying to solve that puzzle.

While smart homes sound expensive, there are potentially huge savings to be made by minimising hospitalisations, managing chronic diseases and increasing healthy lifespans. "People who live more active, more satisfying, happy, fulfilling lives are more economically engaged as well," Professor Maeder explains. "It's better to keep the highest quality of life for as long as possible and hope for a relatively rapid but gentle decline at the end."

Professors Maeder and Williams are also involved with the ARC Research Hub for Digital Enhanced Living, working with colleagues at Deakin University in Victoria and more than a dozen companies, each of which is involved with individual pieces of the smart home puzzle. The pair are also collaborating with a developer to produce a prototype smart home at Flinders' Tonsley campus, and say a basic system could be up and running within five years.

"Western society is ageing fast. We can't just wait for it to happen; we need to be ready," says Professor Maeder. "If you can maintain people in their homes, living happily in familiar surroundings without distress, without duress, it's a much better life."



JANE NICHOLLS

MARINE BIOTECHNOLOGY: THE NEXT WAVE FOR AUSTRALIA

MEET THE RESEARCHER STRIVING TO TAKE OUR HIDDEN MARINE POTENTIAL GLOBAL.

When it comes to Australia's natural riches, we tend to think of landbound resources, such as coal and iron. But for Professor Wei Zhang, there's gold submerged just beyond our shorelines – the kind that could spur a burgeoning new industry.

Founder and Director of the Flinders University Centre for Marine Bioproducts Development (CMBD), Professor Zhang is focused on what lies in Australia's Exclusive Economic Zone – an area spanning some 10 million square kilometres of marine territory.

Since its launch in 2007, the CMBD has been investigating sustainable processing and commercialisation methods for South Australian microalgae, sea sponges, fish, rock lobsters, sea cucumbers and seaweed. The idea is to transform these marine bioresources into high-value products for human nutrition, pharmaceuticals and medical materials.

"Australia has unique marine biological diversity," he says. "Nearly 70% of our marine biota is unique to our region, and marine biotechnology builds on this natural asset."

The international market is already hungry for marine bioproducts, ranging from soil fertilisers and animal feeds to nutritional supplements and preventative medicines. But in 2014, when the global industry was valued at US$176 billion, Australia represented just US$200 million of that.

The good news is that experts predict that Australia's pristine environment and strict regulatory practices put it in a prime position to become a major global player in the years to come.

The CMBD is developing clean, sustainable technologies for existing operations, while also inventing advanced processing technologies and products for new industries. Professor Zhang has a laser focus on immediate business development, and ambitious plans for "Australia's future dream" of establishing new job-creating industries for marine bioproducts.

"South Australia has almost 15% of the world's recorded diversity for red and brown seaweeds, which are the most commercially valuable species. But we don't have endless quantities to use for commercial production," he explains. "It's important to develop technology that's sustainable and conserves the resources and diversity."

Those priorities are at the heart of the CMBD's approach, as well as pursuing energy-efficient and water-saving methods.

"When we work with industry partners, we start with improvements to their technology to minimise waste, improve efficiencies and justify that initial business investment," says Professor Zhang. "Once they taste the sweets of what one of our technologies can offer, then they can move onto the next!"

The CMDB is supported by industry, State Government, Australian Research Council (ARC) and Cooperative Research Centres (CRC) funding, and has already seen the commercialisation of some key projects. Many more are in the pipeline.

One of these, called Microwave Intensified Technology, has transformed the production of seaweed fertiliser by Australian Kelp Products (AKP), a South Australian seaweed products company. A process that once took up to three months now takes six to nine hours, dramatically increasing productivity while reducing use of water and chemicals.

This means the factory space required is just 1% of what it was before the technology was introduced, says Professor Zhang.

That research came through the Advanced Macroalgae Biotechnology Joint Laboratory, established at Flinders in 2013 as a partnership between the CMBD and China's Gather Great Ocean Group – one of the world's largest seaweed processors.

Another of Professor Zhang's concepts is a calcium supplement, to be developed in a collaboration with the CSIRO. "One in six children in Australia are lactose-intolerant and cannot get sufficient calcium from dairy products," he says.

It's important to consume the required nutrients, but it's difficult to get children to eat things they don't like, he adds. "We needed to make it tasty and edible, rather than via capsules or tablets, because they hate them."

The Flinders team combined extracts from brown seaweed and minerals from lobster shells – a seafood-processing waste product – to create Calci-boom, a supplement that can be made into a lunchbox product, such as a jelly or drink. After success in the CSIRO's ON Accelerate program, Calci-boom is now under commercial development.

And that's just the tip of the marine biotechnology iceberg.

Driven by the global market demand for clean, green and effective marine bioproducts, Flinders is now leading a bid to form the first industry-led, national R&D platform for this emerging industry sector, called the Marine Bioproducts and Biotechnology Cooperative Research Centre (MBB-CRC).

The MBB-CRC already has 37 industry and eight university partners on board. Professor Zhang says a CRC is essential to realising Australia's immense marine wealth and boosting its competitiveness internationally.

"The CRC will be a platform to link partners across the value and supply chain, give Australia international influence and connections, and support the growth of our marine biotechnology and bioproducts industry to contribute to what we're dreaming of: an Australian blue economy worth $100 billion by 2025."

Bring on the new Australian gold rush.

PROFESSOR WEI ZHANG

THE GOOD NEWS IS THAT EXPERTS PREDICT THAT AUSTRALIA'S PRISTINE ENVIRONMENT AND STRICT REGULATORY PRACTICES PUT IT IN A PRIME POSITION TO BECOME A MAJOR GLOBAL PLAYER IN THE YEARS TO COME.

JANE NICHOLLS

RUNNING ON EMPTY

GUIDELINES CREATED BY FLINDERS HYDROGEOLOGISTS ARE LEADING THE WORLD IN GROUNDWATER MODELLING THAT COULD HELP PREVENT CITIES LIKE CAIRO OR CAPE TOWN FROM ONE DAY RUNNING COMPLETELY DRY.

Humans have been interested in water sources since they first crossed the African savannah, but a perfect storm of population growth and climate change is focusing the minds of the world's best and brightest on the field of hydrogeology like never before.

"In 2018, Cape Town almost reached 'Day Zero' – that is, its taps running dry – and may yet experience it in 2019," says Professor Craig Simmons, who worries that Australia is also sleepwalking into a future water crisis of its own making. And there are plenty of other global cities, including Bangalore, Beijing, Cairo, Jakarta, London, Mexico City, and Miami, that are also facing the possibility of similar scenarios.

In the coming decades, Australia's population is projected to increase by about 60%, reaching 36 million by 2050. This, "at a time when large swathes of Australia will be becoming drier," Professor Simmons explains.

"People don't believe that any Australian city will have a Day Zero," he says. "I'm not so sure. Granted, Australia currently has plenty of groundwater, but water in the ground is like money in the bank – if you have more going out than coming in, you'll eventually end up in trouble."

As the Matthew Flinders Distinguished Professor of Hydrogeology at Flinders University and Director of the Flinders-headquartered National Centre for Groundwater Research and Training (NCGRT), Professor Simmons is no alarmist. He's devoted his career to trying to ensure that the parched dystopias that feature in sci-fi films never actually eventuate.

He says if dams run dry, water can be sourced elsewhere. Seawater can be desalinated, wastewater recycled, and groundwater pumped to the surface. Of course, when tapping into aquifers, or engaging in activities near them, there's always the possibility of exhausting or poisoning them.

That's where the Australian Groundwater Modelling Guidelines (AGWMG) come in.

It's no simple task, figuring out how much water is stored in these subterranean reservoirs, or the rate that water is flowing in and out, not to mention the impact of activities such as farming, mining and fracking.

Professor Simmons says previous methods of modelling groundwater in Australia were the best that could be achieved given the available science. However, by 2010, it was clear that the existing guidelines "needed an overhaul" – and he and his NCGRT colleagues took up the challenge.

They drew on the work that they and the groundwater community were already doing, he says, and partnered with Sinclair Knight Merz (now part of the Jacobs Engineering Group) – an international company specialising in strategic consulting, engineering and project delivery.

To support their groundwater modelling, NCGRT team member Professor John Doherty developed 'parameter estimation software' (or PEST), which allowed for more effective, efficient and powerful modelling of groundwater systems.

"Acknowledging uncertainty is crucial – no modelling guidelines will ever allow you to estimate volumes or flows

PROFESSOR CRAIG SIMMONS

to three-decimal-place accuracy," says Professor Simmons. "But better modelling allows for better-informed decisions. You can establish more accurate risk profiles, then decide how cautious you want to be about, for instance, using groundwater to irrigate a farm when doing that may result in a nearby wetland drying out."

Since their release in 2012, the AGWMG have been the go-to guidelines for Australian businesses and regulators. They have also contributed to – and often led – the global debate on many hydrogeological issues, helping to inform the modelling of groundwater in nations such as Egypt, Italy, Iran, Japan, Kuwait, Mongolia, Russia, Spain, South Africa, Tanzania and Turkey.

In Australia, the guidelines underpin groundwater models that are commonly used in Environmental Impact Statements, done whenever a business or government wants to undertake activities that draw water from, or could potentially affect an aquifer.

The real-world impacts of the guidelines are profound. Groundwater accounts for around one-third of the water used in Australia, facilitating the $34 billion generated by industries such as agriculture and mining. More sophisticated modelling and better stewardship of groundwater resources means major export industries can continue to enjoy sustainable growth.

"AUSTRALIA CURRENTLY HAS PLENTY OF GROUNDWATER, BUT WATER IN THE GROUND IS LIKE MONEY IN THE BANK – IF YOU HAVE MORE GOING OUT THAN COMING IN, YOU'LL EVENTUALLY END UP IN TROUBLE."

Professor Simmons has established himself as one of the world's most prominent hydrogeologists. In the two decades he's spent at Flinders, he's played a seminal role in ensuring its place as the epicentre of hydrogeological research excellence in Australia.

Flinders has long been the "key groundwater research and training higher education institution in Australia", he says, cautiously acknowledging that it outperforms the likes of MIT, Princeton, Yale and the University of Oxford.

"Flinders does rank above many top-tier universities in this field in the global rankings," he says.

BILL CONDIE

GUT FEELINGS

A NEW RESEARCH CENTRE INTO MENTAL HEALTH ENCOMPASSES SOME SURPRISING APPROACHES.

Not everyone would launch an investigation into mental health by looking at the human gut, but that's where Professor Nick Spencer believes we will find answers to many questions that, until now, have been elusive.

Professor Spencer works at Flinders University's College of Medicine and Public Health. He completed his PhD on the gut 21 years ago and admits that the study is not for everyone.

"The gut was not a very popular organ for a variety of reasons. It was thought to be just an organ to digest food and absorb nutrients and pass those nutrients on into the bloodstream so that we can survive," he says.

Even today, it is little understood. So when the links between the brain, behaviour and the microbes that live in our intestines – our microbiome – began to be noticed, Professor Spencer took a keen interest.

Faecal transplants between patients are showing promising effects on the wellbeing of human patients and have been shown to cause behavioural changes in animal models. But investigating how this all might work presented another problem – no one knew very much about the sensory nerves in the gut.

"Until five years ago, no one had ever identified where one of the major populations of sensory nerve endings is located in any internal organ of any species," says Professor Spencer.

So before he could even start to work out how the microbiome affected the mind, he needed to come up with a technique to observe the nerve endings. He did that by injecting a tracer into a collection of sensory neutrons near the spinal cords of mice. That has allowed scientists for the first time to visualise where the key sensory nerve endings are located and how they are involved in the gut-brain communication. This technique took a long time to develop.

"It's really exciting. Because understanding how the contents within the gut wall communicate with the sensory nerves can uncover major clues into gut-brain health and wellbeing," says Professor Spencer.

He is now working on step two of the research to discover precisely how the sensory nerves in the gut are activated.

"THE COMPLEX CAUSES OF MENTAL HEALTH PROBLEMS AND THE NEED TO RESPOND TO SUCH COMPLEXITY REQUIRES THAT WE TAKE A MULTIDISCIPLINARY APPROACH IF WE ARE TO MAKE ANY IMPACT."

It was precisely these unexpected complex links which Professor Mike Kyrios – Vice President and Executive Dean of Flinders' College of Education, Psychology and Social Work – had had in mind when he proposed a new research centre on mental health.

The Órama Institute is designed to be a multi-disciplinary research institute for mental health, wellbeing and neuroscience.

"The complex causes of mental health problems and the need to respond to such complexity requires that we take a multidisciplinary approach if we are to make any impact," says Professor Kyrios.

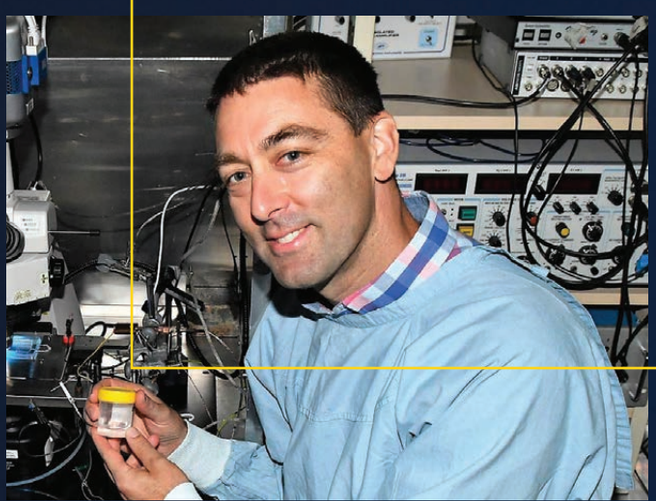
"Biological, social, developmental and individual factors are all involved in the cause of mental health problems, while solutions demand coordination of clinical, policy and technological advances from multiple professions, disciplines, public organisations and stakeholders."

The Órama Institute, a Greek word meaning "vision", contributes a unique blend of disciplines examining positive wellbeing and mental health disorders.

"We will also work with the full spectrum of external partners, locally, nationally and internationally, including state and federal governments, health and mental health services, professional groups, communities and community organisations," says Professor Kyrios.

"We aim to be a major 'go to' mental health and wellbeing institute when government is seeking advice on mental health and wellbeing matters."

PROFESSOR NICK SPENCER



BILL CONDIE

PRACTICE MAKES PERFECT

HOW A NEW ACADEMIC CENTRE IS BRINGING TOGETHER ALL SOCIAL WORK'S STAKEHOLDERS.

Growing up on a farm, Professor Sarah Wendt came to understand a thing or two about isolation. And when she became a social worker, those insights began to inform her work, especially around domestic violence.

"I was extremely interested in how rural and remote women's experiences are shaped by the context in which they live, and how they understand and respond to domestic violence," says Professor Wendt of Flinders University's College of Education, Psychology and Social Work.

Before her PhD, she had worked the crisis telephone lines, enabling women to flee violent situations at the point of crisis, and working with women in the women shelters.

And while her 2009 thesis, Domestic Violence in Rural Australia, explored many women's country experiences, her experience told her that it's not just the tyranny of distance that can cause isolation.

"It can be physical barriers to seek help, but it can also be social isolation," says Professor Wendt. "Men's use of violence in intimate relationships isolates women from family, friends, community, employment and leisure."

"So, domestic violence erodes aspects of women's lives and brings trauma into their lives. How they understand that trauma, and how it relates to domestic violence, is often complex. How do they seek help…these things are unique and make it more difficult to understand and respond to domestic violence."

But always there is one essential element – coercive control – at its centre.

"When you look across diverse groups of women, you will see that pattern of behaviour, no matter if you're rich, poor, religious or not, living in a rural community, or urban."

It was Professor Wendt's roots in the practical business of social work which drove her vision for the groundbreaking new centre she and her team have established at the University.

The Social Work Innovation Research Living Space, or SWIRLS, began with Professor Wendt's vision of engaging more clearly and directly with relevant key stakeholders in the social work 'industry'. It launched in March 2019.

"I believe that practice really influences research in social work, and research can influence practice in social work.

"And so those two things have to have a relationship, and when that works well, we can educate the future workforce of social workers in much more up-to-date ways."

SWIRLS is designed to engage practitioners and organisations across multiple fields, although its main current focus is in the area of domestic violence, child protection, homelessness and youth. It is designed as a space where researchers and practitioners, policy makers or other key stakeholders can come together, to confront problems together and co-design ways to tackle them.

"So, when I say practice, I mean working with people on the ground," says Professor Wendt. "But the ultimate outcome is not just naming problems, but doing something about them."

Professor Wendt sees it as a two-way street.

"You can have big models that have been tested and trialled, from which we can learn a lot from and apply into practice.

"But, I also think there's a lot of work happening in practice that is invisible, and that we don't know about."

SWIRLS has already forged close links with the South Australian government through agencies for child protection and Housing SA. It also has a partnership with the Early Intervention Research Directorate, the EIRD, which was established in response to the 2016 Nyland Royal Commission into the Child Protection System.

Professor Sarah Wendt

The Nyland report recommended more research to increase the evidence space about how we can better improve systems, practices and child protection – an obvious fit with the SWIRLS' vision.

SWIRLS also works with Women Safety Services South Australia tackling domestic and family violence, the Department of Child Protection, and KWY: an aboriginal specialist, family violence service.

Those three agencies are looking particularly at how collaborations can deliver better responses to families with complex needs.

"Our research is straddling two things," says Professor Wendt. "Collaboration and changing practice, but also researching that practice as we go along so that we can trial and test and learn what we're doing before we impose massive solutions onto a system that's already complex."

SWIRLS has quickly developed a reputation among researchers for an academic centre that is no ivory tower, but committed to including the lived experiences of individuals, families, groups and communities.

"We interview children or women who have experienced violence. We interview men who use violence. We try and work with families to have a say about their experiences and their responses. SWIRLS is committed to being inclusive of those that are doing the practice, and those that are receiving the practice."

Professor Wendt acknowledges that domestic violence, by its nature, is often perceived as being private and kept secret. "That's why we have to have awareness raising," she says, "and I think we, in Australia, for the first time have started to really increase the awareness of domestic and family violence, and that's a good thing.

"But, it's going to be slow in how we try and break down those barriers of privacy, or secrecy. Shame and embarrassment are the biggest contributing factors, firstly, why women don't seek help for domestic and family violence."

And Professor Wendt believes that with awareness raising will come a new focus on changing men's behaviour.

"The focus has always mainly been on, of course understandably, how you help women and children. I think now we are at a point in time, particularly in Australia, where you'll now start to see much more conversations around, 'Well, what are we doing about the perpetrator?'

"Instead of expecting women and children to deal with this all on their own, questions are at last being asked about how we enable behaviour and attitudinal change."

Historically, this has been attempted through men's behaviour change programs, typically a 12-week programme. But it is difficult to determine if these have been effective. "So, we're starting to now look at what it means to engage men," says Professor Wendt. "We want long-term, sustainable change and I think we've expected too much of a 12-week program. We have to start now looking at other ways in which we're going to work with men to stop this issue".

"SHAME AND EMBARRASSMENT ARE THE BIGGEST CONTRIBUTING FACTORS, FIRSTLY, WHY WOMEN DON'T SEEK HELP FOR DOMESTIC AND FAMILY VIOLENCE."

ENGAGE

AT FLINDERS UNIVERSITY WE HAVE A MISSION TO CHANGE LIVES AND CHANGE THE WORLD. THE MOST SIGNIFICANT WAY WE DO THIS IS THROUGH OUR HIGH IMPACT RESEARCH.

Central to achieving this mission is our collaboration with business, industry, government and the community.

We welcome and encourage partnerships across these groups, and invite you to contact us to see how you can participate.

Help us to address challenges of local, national and global significance, and ultimately deliver outcomes for the betterment of society.

Help our Brave Minds make a difference.

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