IMPACT

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A tech powered human driven future

ATSE

Statement of the International Council of Academies of Engineering and Technological Sciences (CAETS) on the invasion of Ukraine.

The International Council of Academies of Engineering and Technological Sciences (CAETS), as represented by the undersigned, is dismayed by the unprovoked large-scale military invasion of Ukraine at the instigation of the Russian government. We condemn this attack on the territorial integrity, sovereignty and independence of Ukraine. Our thoughts are with the people of Ukraine, our sympathy and solidarity go out to them.

CAETS considers the invasion as an attack on the fundamental values of freedom, democracy and self-determination, which in turn provide the basis for academic freedom and opportunities for scientific and technological progress. We wish to express our solidarity with the Academy of Technological Sciences of Ukraine and with all Ukrainian scientists and engineers in the face of the ordeals they are going through as a result of the invasion of their country.

CAETS also wishes to pay tribute to the courageous stand taken by thousands of Russian scientists in an open letter denouncing the aggression towards Ukraine by the Russian Federation and calling for its immediate cessation.

The courageous defence advanced by the Ukrainian people shows their uncompromising attachment to freedom. In a multidimensional world, close scientific and technical international cooperation, in science and industry as in many other fields, is a necessity and requires respect for freedom; the freedom of peoples to choose their future and their freedom to think and express themselves.

CAETS and its member academies are committed to enabling a future in which peace prevails and standards of living and prosperity are secured through international cooperation in science and innovation. To that end CAETS calls for an immediate cessation of hostilities followed by meaningful peace talks under the auspices of the United Nations.

This statement was endorsed by the following CAETS member academies:

Academia Nacional de Ingenieria of Argentina
Australian Academy of Technological Sciences and Engineering
Royal Belgian Academy Council of Applied Sciences
Canadian Academy of Engineering
Croatian Academy of Engineering
Engineering Academy of the Czech Republic
Danish Academy of Technical Sciences
Council of Finnish Academies
National Academy of Technologies of France
National Academy of Science and Engineering of Germany
Hungarian Academy of Engineering
Irish Academy of Engineering
Engineering Academy of Japan
National Academy of Engineering of Korea
Academy of Engineering of Mexico
Netherlands Academy of Technology and Innovation
Royal Society Te Aparangi of New Zealand
Nigerian Academy of Engineering
Norwegian Academy of Technological Sciences
Slovenian Academy of Engineering
South African Academy of Engineering
Real Academia de Ingenieria of Spain
Royal Swedish Academy of Engineering Sciences
Swiss Academy of Engineering Sciences
Royal Academy of Engineering of the United Kingdom
National Academy of Engineering of the United States

The Academy acknowledges the Traditional Owners of the lands on which we meet and work and we pay our respects to Elders past and present. We recognise the deep knowledge and practices embedded in the oldest continuous culture on the planet. Australia's history of engineering, technology and applied science spans more than 60,000 years.

PUBLISHER
Australian Academy of Technological Sciences & Engineering
We are a Learned Academy of independent experts. We bring together Australia's leading experts in applied science, technology and engineering to provide impartial, practical and evidence-based advice on how to achieve sustainable solutions & advance prosperity.

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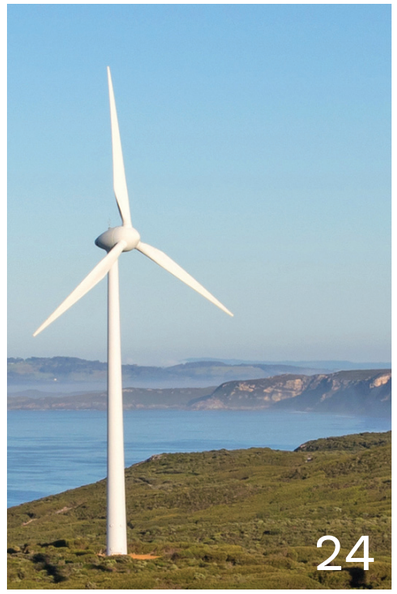


FEATURES

NEWS & REGULARS

What is 'human driven technology'?

This issue of IMPACT is devoted to ways ATSE Fellows are shaping our future with technology that's 'human driven'.

Professor Hugh Bradlow
FTSE
Hugh Bradlow is the President of the Australian Academy of Technological Sciences & Engineering.

That begs the question: what is 'human driven technology'?

In my view, three criteria need to be satisfied:

– It must fulfil some clear human need,

– It must be intuitively usable by a non-expert,

– It must be affordable to the vast majority of people.

I'll pick an example of the last condition first.

Among the many interventions necessary to address climate change, we clearly need to electrify the transport system. However, Tesla's 'let them eat cake' solution to this problem is not 'human driven'.

These vehicles may make their wealthy owners feel self-righteous, but they don't change the purchasing choices of most consumers and businesses because the cars are priced out of their range. The net impact on the transport system is therefore negligible.

We've also seen many technologies fall into the trap of not being intuitively usable by non-experts.

The potential of so-called 'smart homes' has been around for decades. Among other things, these systems promise to optimise household energy consumption. The actual technology is now readily available and reasonably priced. But short of hiring a technician to install the system, maintain it, and constantly support you to use it, smart home systems are completely unworkable for the average person. This means adoption has largely been limited to enthusiasts.

A technological solution that isn't human driven isn't a solution at all. But I think the question of utility is always going to surprise us.

When I first saw the technical specifications for SMS in the early 1990s, I wondered who in their right mind would communicate this way. You needed to do multiple key presses on a 12-button keypad using a weird predictive text system called T9.

Yet even non-technical people adopted it because the human need it satisfied was so overwhelming that people overcame the lack of usability.

Mind you, it did lead to some funny results. I recall my horror when I received a message from my wife saying, 'foot in part gone'.

What she meant to say was 'don't go past home' and she did not check the T9 interpretation!

This issue of IMPACT will inform you about the many initiatives ATSE and our Fellows are undertaking to meet those three criteria and make a real difference in the world.

Engineering hope

Climate disaster, pandemic, cyber threats, food and water security: it's tempting to live in fear and pessimism.

Kylie Walker
Chief Executive Officer
Kylie Walker is the CEO of the Australian Academy of Technological Sciences & Engineering.

But science and technology stand out as offering many reasons for hope: we have the technology, here and now, to shift the dial.

Australia's — and the world's — resilient future lies in the confluence of technology and humanity. Innovation and sustainability, not just for the environment, but also for human connection, food security, a way of life.

If we take an integrated approach to designing and applying technology, and if we link economic security and sustainability with environmental security and sustainability, an extraordinary future awaits.

Technological breakthroughs made during the COVID-19 pandemic demonstrate the potential. Telehealth, mRNA vaccines and remote learning technologies are all examples of how expediency accelerates the pace of technology adoption and advancement.

Imagine what we could do with a strongly-backed national strategy to translate our excellent research into ground-breaking innovations, and a workforce that can create and use these technologies.

Resilient systems are a non-negotiable for Australia's thriving future. Resilience in our infrastructure, supply chains, energy systems, and in our skilled and connected workforce.

Realistic, data-informed planning for resilience must become second nature if we are to prepare for, survive and thrive through the coming challenges.

These resilient systems should also be designed around a decarbonised future, to slow warming, and even unlock opportunities to reverse the worst effects of climate change.

This, too, is a human driven approach: securing our future liveability through ambitious short-term emissions targets as part of a longer-term plan, and transitioning to an energy system fully powered by renewable sources, while deploying low-carbon technologies in other high-emitting sectors.

Emerging technologies will extract carbon from our atmosphere, either for storage or to use as a resource. We have the tools to do the former and the research now-how to do the latter. But only if we have a plan to do both.

Resilience and sustainability are, of course, interlinked. This connecting principle of sustainability must run as a thread through all of our systems.

It is not enough to have a sustainable energy system if we continue to create around 67 million tonnes of waste each year. We have the technology to create a circular economy: now we need the design, the will, and the investment.

Australia's research advantage touches most sectors of the economy. Advanced manufacturing, services enabled by artificial intelligence, quantum computing, and medical devices, are just a few areas where we have the knowledge and potential to create new markets.

A strong research sector and a national plan to translate that research will diversify our economy, making it more profitable, resilient, and capable of improving quality of life for Australians.

Finally, fundamentally, a technology-powered future must be human driven.

It is people who must bring the skills and creativity to devising this future, and people who must benefit from technological advancement, be that through better health and aged care, better jobs, education, or a cleaner, more sustainable environment.

A technology-powered, human driven future is a future with hope. A future in which floods and fires are fewer and more manageable; in which the greatest ideas are supported by our research infrastructure and investment to become the greatest game changers; in which everyone has the skills to be technology users; and in which we train and promote a genuine diversity of leaders in applied science, engineering and technology.

News from the Academy

ATSE to run $41.2m initiative to elevate women in STEM

JANUARY 2022

ATSE has been named the sole implementing partner for the Australian Government's seven-year $41.2 million *Boosting the Next Generation of Women in STEM* fund.

The transformational program, named *Elevate*, will award up to 500 undergraduate and postgraduate scholarships to women in science, technology, engineering and mathematics (STEM).

It aims to address gender inequities in STEM by fostering more women-led industry-academia collaborations in applied research and business, educating women, and propelling more women into senior leadership.

ATSE and our partners will co-design a world-class program spanning industry, academia and government to upskill women with STEM qualifications, research, and business expertise, so they can lead and shape a dynamic and impactful STEM sector.

Academies partner for science and tech diplomacy

APRIL 2022

ATSE will collaborate with our sister academy, the Australian Academy of Science, to deliver the Australian Government's $18.2 million *Global Science and Technology Diplomacy Fund – Strategic Element*.

Over the next four years, the fund will support international collaboration to enhance Australia's profile in science and technology research and application.

Australian business, entrepreneurs and researchers can capitalise on international opportunities to commercialise their cutting-edge products and services and strengthen scientific collaborations.

The fund will advance strategic areas such as:

- making Australian advanced manufacturing more competitive
- artificial intelligence and quantum computing to create a safe, trusted and secure digital economy
- producing hydrogen to provide a zero-emissions fuel source with strong export potential
- emerging applications of RNA (including mRNA) vaccines and therapies to improve health outcomes.

Engineering leaders appointed to Board

NOVEMBER 2021

Visionary engineering leader Professor Elanor Huntington FTSE has been named a Board Director of the Australian Academy of Technological Sciences and Engineering (ATSE).

Professor Huntington has a compelling vision of how engineering must change to meet the challenges of the future. She brings a wealth of experience, vision, and commitment from multiple boards and agencies across Australia.

As Dean of The Australian National University College of Engineering and Computer Science, Elanor helped to increase and diversify funding, including a sevenfold increase in philanthropic funding and a twofold increase in industry research funding. She is currently the Executive Director – Digital, National Facilities & Collections for CSIRO.

Professor Huntington also holds multiple 'first woman to …' credits in her varied experience and is on a mission to leave behind a better and more inclusive STEM sector.

Professor Iven Mareels FTSE has also been elected for his second term on the Board, and will continue as ATSE's Vice President Financial Sustainability.

Professor Mareels was elected to the Academy in 2000, and served one term on the Board since 2018. In the last two years he was Chair of the Audit and Risk Committee and Vice-President Financial Sustainability.

Above: Professor Elanor Huntington FTSE and Professor Iven Mareels FTSE have been appointed to the ATSE Board.

Professor Mareels brings a mixture of academic leadership from the research and development sector, and industry experience that spans from start-ups to multinationals.

Iven's experience as Director for the Centre for Applied Research in IBM Australia / New Zealand is an asset. In 2008 he was awarded the Clunies Ross Award for a new approach to managing large scale open channel water distribution networks.

"We're delighted to welcome Professor Huntington to ATSE's Board, and thank Professor Mareels for his continued leadership and service," said ATSE President Hugh Bradlow.

"Their vision, diligence, and commitment to boosting the role of technological scientists and engineers in shaping a progressive Australian society has been a defining feature of their careers."

Joint statement from Learned Academies on ARC grants veto

FEBRUARY 2022

We, the Presidents of Australia's Learned Academies, are committed to a research and innovation system underpinned by the expertise and talent of researchers across the sciences, humanities, technology and engineering, social sciences, and health and medicine.

We urge that our system be consistent with world's best practice, where expertise in both conducting research, and evaluating which research to support, is essential.

This provides confidence to the community that pays for it, the politicians who prioritise it, and the researchers who conduct it, ensuring that the outcomes of our research support a culturally rich, economically prosperous and secure Australia.

Professor Lesley Head FASSA FAHA
President, Australian Academy of the Humanities

Professor John Shine AC FRS
President, Australian Academy of Science

Professor Hugh Bradlow FTSE
President, Australian Academy of Technological Sciences and Engineering

Professor Richard Holden FES FASSA
President, Academy of the Social Science in Australia

Professor Ingrid Scheffer AO FRS FAA
President, Australian Academy of Health and Medical Sciences

New research commercialisation fund a welcome step to bolster Australian skills and jobs

FEBRUARY 2022

ATSE welcomed the (now former) Hon Prime Minister Scott Morrison's $2.2 billion university research commercialisation announcement.

Industry and academic collaboration is essential for growing Australian skills, creating local jobs and unlocking sovereign technological capabilities.

Professor Hugh Bradlow FTSE, President of ATSE said the announcement is a welcome boost to the research sector and will play an important role in transforming early-stage research into commercial success and spurring a technology powered, human driven future for Australians.

"The Australian Academy of Technology and Engineering is eager to ensure the fund helps increase industry's appetite to develop new ideas. However, it is also important not to neglect curiosity-driven research which creates the ideas for new commercial opportunities.

"We applaud the government's recognition that we need a new breed of research entrepreneur. Research commercialisation will be an essential cog needed for a technology powered, human driven future which builds Australian sovereign capabilities, provides skills, and creates jobs.

ATSE and the Federal Election

FEBRUARY 2022

As Australia grapples with the profound economic impact of COVID-19, the country has a unique opportunity to position itself as a technological powerhouse driven by a clean and sustainable economy, highly skilled workforce and world-class research activity and commercialisation.

The coming decade will see the culmination of a unique set of challenges associated with decarbonising the economy, managing the decline of many industries, and training the workforce needed for an increasingly digital future.

In the lead up to the Federal Election, ATSE urged all parties to commit to a technology powered, human driven future.

ATSE provided a submission to the 2022-23 Federal Budget

To meet Australia's economic, environmental, and industrial ambitions, a focused plan is required to create a technology powered, human driven future for all Australians.

ATSE recommends three priorities:

1. Cultivating a skilled STEM workforce
2. Creating conditions for increased research collaboration, translation, and commercialisation
3. Applying a technology-based approach to managing and mitigating climate change.

Response to the Federal Budget

MARCH 2022

The recent Federal Budget was a starting point, but lacks a long-term strategy to safeguard Australia's economy, society and environment.

The (formers) Government's election-eve budget presented a vision of a skilled, technology-powered Australia but fell short of making a long-term investment in supporting Australia's technological ambitions, leaving the nation exposed to workforce shortages and an unpredictable future.

ATSE President Hugh Bradlow said, "We welcome funding for green energy infrastructure and expanding the STEM workforce."

Budget reply a starting point for a renewable future and strengthened sovereign capabilities, but lacks detail

APRIL 2022

The Five pillar plan outlined by (former) opposition leader, Anthony Albanese, outlines a promising direction but a long-term holistic strategy is needed to safeguard Australia's economy, society and environment.

The Powering Australia Plan could play a critical role in fast-tracking Australia's commitment to net-zero emissions by 2050. The ratcheting up of low-carbon technologies like solar, wind and energy storage (batteries and pumped hydro), combined with electrification of transport and sustainably designed buildings must be accelerated to drive emission reductions while safeguarding Australian jobs and economic prosperity.

Election Position Statement

MAY 2022

In the lead up to the 2022 federal election and beyond, ATSE called on all political parties to commit to a future which is:

Technology enabled: The development and industrial implementation of new technologies is essential to facilitate a future of economic growth and high standards of living.

Resilient: There must be sufficient resources and adaptability to tackle the challenges of the future, including natural disasters, the impacts of climate change, geopolitical uncertainty, and cyberattacks, through new and emerging technologies and retraining displaced workers in the decarbonising economy with future-focused digital skills.

Sustainable: Environmental, social, and economic sustainability are critical to enable a high quality of life for Australians into the future. This must include the development of sovereign manufacturing capabilities and a transition to a circular economy.

Decarbonised: As natural resources deplete and the effects of climate change proliferate, it is crucial for industrial and economic activities to be carbon neutral. Australia has a unique opportunity to lead in repositioning its current resource dependent economy into a carbon neutral economy based on renewable energy and other new and emerging technologies for a sustainable future.

Economically diverse: Shifting economic activities toward multiple sources from multiple sectors, expanding domestic markets (within a circular economy) and expanding exports, are all necessary to embed resilience into the economy.

Internationally engaged: The most pressing challenges of our time are global — so their solutions require international conversations and collaborations to be effective — and Australia needs to take a leadership position in these discussions.

Human centred: Principally, this vision must be human-centred and driven. Economic activity and scientific and technological advancement are enablers to deliver progress that serves all our people and the planet.

NEW FELLOWS

New Fellows 2021

One of Australia's most esteemed Aboriginal educators, Australia's leading net zero emissions innovators, a bush-fire predictor and an inventor of rapid COVID-19 saliva testing are among the trail-blazing group of Fellows elected in 2021 to the Academy of Technology and Engineering (ATSE).

The new Fellows are at the top of their fields, encompassing sustainable agriculture and construction, renewable energy, telecommunication, mineral resources, civil engineering, pharmaceuticals, robotics and artificial intelligence.

Renowned Indigenous leader, Distinguished Professor Marcia Langton FTSE from the University of Melbourne, has been named an Honorary Fellow for championing the contribution of Aboriginal and Torres Strait Islander knowledge systems and science in shaping Australia.

Professor Richard Eckard FTSE from the University of Melbourne has developed the first greenhouse gas accounting tools for agriculture. His research has provided the scientific basis for carbon offset methods, including sequestering carbon in soil.

Professor Jason Sharples FTSE from the University of NSW, a Bundjalung man, uses predictive mathematical models to prevent catastrophic bushfires. His research framed the recommendations of the NSW Bushfire Inquiry (2019-2020).

Dr Sue Keay FTSE, one of Australia's most influential leaders in artificial intelligence and robotics, led Australia's first robotics roadmap.

The group of Fellows have also been at the forefront of fighting the COVID-19 pandemic. Dr Andrew Nash FTSE from CSL, one of the world's largest biotech companies, has been at the vanguard of combatting the virus through vaccine manufacturing. Distinguished Professor Dayong Jin FTSE from the University of Technology, Sydney helped develop a saliva test for COVID-19 that detects the virus within 10 minutes.

The new Fellows also include private sector leaders including sustainable mining champion, Sandeep Biswas, who has set the goal for his company, Newcrest Mining, of net-zero carbon emissions by 2050; and Kelly Bayer Rosmarin FTSE, who has transformed telecommunications company Optus through launching its 'Living Network'; a collection of on-demand network features which adapt to customer needs.

ATSE President Hugh Bradlow FTSE said the new Fellows are front-runners in growing Australia's standing as a top technologically-driven nation.

"ATSE Fellows are elected by their peers for outstanding contributions to advancing engineering, technology and applied science: they are shaping Australia's future," Professor Bradlow said.

"They are at the forefront of combatting climate change — creating alternatives to cement for construction; and new lupin and oat varieties in the face of surging demand for plant-based protein.

"They are shaping Australia's digital future by equipping children with computing skills urgently needed for their careers, transforming our telecommunications landscape, and using artificial intelligence to counter electronic warfare."

Ten of the new Fellows are women and nearly half are from culturally and linguistically diverse backgrounds, reflecting the Academy's commitment to gender equity and diversity.

Louise Adams FTSE
Chief Operating Officer, Aurecon

Louise Adams is an engineer, business manager and a prominent leader in infrastructure.

Professor Kenneth Baldwin FTSE
Director, ANU Grand Challenge: Zero-Carbon Energy for Asia-Pacific

Professor Ken Baldwin is a leader in the global energy transition and has created significant initiatives to address energy change in response to climate change.

Kelly Bayer Rosmarin FTSE
CEO, Optus

Kelly Bayer is behind the evolution of Optus as a technology company, with the industry-leading launch of the 'Living Network' to empower and enrich customer experiences and interactions with their mobile network.

Sandeep Biswas FTSE
Managing Director and CEO, Newcrest Mining

Sandeep Biswas is a global leader in sustainable mining and his company has become a leader in the mining technique known as block-caving, resulting in reduced downtime and increases in productivity and safety.

Professor Elizabeth Croft FTSE
Dean of Engineering, Monash

Professor Elizabeth Croft is an expert in human-robot interaction and her research seeks to advance the collaboration between people and robots in safe, predictable and helpful ways.

Professor Wenhui Duan FTSE
Director of ARC Nanocomm Hub, Monash

Professor Wenhui Duan is a structural engineer building a more sustainable and liveable Australia by using the science of the ultra-small to transform construction materials.

Professor Richard Eckard FTSE
Professor of Sustainable Agriculture, University of Melbourne, and Director, Primary Industries Climate Challenges Centre

Professor Richard Eckard is a world authority on sustainable agricultural production and he developed the first greenhouse gas accounting tools for agriculture.

Professor Karen Hapgood FTSE
Executive Dean of Science, Engineering and Built Environment, Deakin

Professor Karen Hapgood is a leading chemical engineer whose research on engineering powder particles is used worldwide by the pharmaceutical industry to enhance manufacturing processes for new drugs.

Distinguished Professor Dayong Jin FTSE
Australian Laureate Fellow, Director, Institute for Biomedical Materials & Devices, UTS

Distinguished Professor Dayong Jin is an acclaimed scientist who develops biomedical, analytical, and imaging devices that detect diseases much earlier, including cancer.

Dr James Johnson FTSE
CEO, Geoscience Australia

Dr James Johnson is a geologist with over 35 years' experience and is an international leader in applying geoscience to solving society's major economic, social and environmental challenges.

Dr Sue Keay FTSE
Chief Executive Officer, Queensland AI Hub, and Chair, Robotics Australia

Dr Sue Keay is one of Australia's most influential leaders in artificial intelligence and robotics. She led the development of Australia's first robotics roadmap.

Dr Dale Lambert PSM FTSE
Chief of Cyber and Electronic Warfare Division, Defence Science and Technology Group

Dr Dale Lambert is a world class scientist in high-level information fusion, using artificial intelligence to integrate and analyse multiple data sources enabling decision superiority for the defence and intelligence communities.

Professor Chengdao Li FTSE
Professor and Director, Western Crop Genetics Alliance, Murdoch University and Department of Primary Industries and Regional Development

Professor Chengdao Li is a geneticist and breeder who has developed breeding technologies and released world leading varieties to facilitate Australia's barley industry transformation.

Distinguished Professor Ivan Marusic FTSE FAA
Deputy Dean (Research), The University of Melbourne

Distinguished Professor Ivan Marusic is an eminent researcher on fluid mechanics — Ivan's discovery of 'superstructures' in wall-bounded turbulence was a breakthrough.

Professor Sally McArthur FTSE
Director, Manufacturing Futures Research Institute, Swinburne University of Technology

Professor Sally McArthur is a leading biomedical engineer and passionate about using engineering principles to improve human wellbeing. At CSIRO she was a team member who developed extended wear contact lenses.

Dr Graeme Moad FTSE FAA
CSIRO Fellow, CSIRO Manufacturing

Dr Graeme Moad is a renowned chemist at the forefront of polymer science. Graeme was a key inventor of CSIRO's RAFT technology, which has garnered worldwide acclaim.

Dr Andrew Nash FTSE
Chief Scientific Officer, CSL

Dr Andrew Nash is a global leader in biopharmaceuticals. CSL is one of the world's largest biotech companies and has invested more than US$4 billion in R&D in the last five years.

Dr Michael Robertson FTSE
Deputy Director, CSIRO Agriculture and Food

Dr Michael Robertson is an outstanding agricultural scientist playing a crucial role in research addressing the existential challenges facing Australian farmers in a changing climate.

Kylie Sproston FTSE
Chief Executive Officer, Bellberry Limited

Kylie Sproston is a chartered engineer and internationally experienced leader in the pharmaceutical and biotechnology industries with a strong focus on manufacturing.

Professor Trish Williams FTSE
Cisco Chair and Professor of Digital Health Systems, Flinders University

Professor Trish Williams is passionate about improving healthcare through technology. Trish led a project to develop a benchmark for hospitals to evaluate their digital infrastructure. This benchmark is now an international standard.

Professor Andrew Parfitt FTSE
Provost and Vice-Chancellor, University of Technology Sydney

Professor Andrew Parfitt is a respected university administrator with a strong background in engineering and technology, including telecommunications and space science.

Professor Jason Sharples FTSE
Professor of Bushfire Dynamics, University of NSW

Professor Jason Sharples is a mathematical scientist and internationally recognised expert in dynamic bushfire behaviour and extreme bushfire development.

Professor Hugh Williams FTSE
Enterprise Professor, Melbourne Business School and The University of Melbourne

Professor Hugh Williams is best known as one of the inventors of Infinite Scroll and leader of Google Maps' product and engineering teams. He also held executive roles at eBay and Microsoft.

Distinguished Professor Irene Yarovsky FTSE
School of Engineering, RMIT University

Distinguished Professor Irene Yarovsky is a world leading researcher. She is co-leader of the Australian Steel Innovations Research Hub where academia and industry work in an integrated, value chain-wide approach on projects including sustainability of iron and steelmaking.

Professor Xiao Lin Zhao FTSE
Associate Dean (International), Faculty of Engineering, UNSW Sydney

Professor Xiao Lin Zhao leads research into sustainable alternatives to cement, the world's single biggest industrial cause of carbon pollution, including work on concrete utilising seawater, sea sand, recycled aggregate and industrial waste such as slag and fly ash.

HONORARY FELLOW

Distinguished Professor Marcia Langton AO FTSE FASSA
Associate Provost, University of Melbourne

Distinguished Professor Marcia Langton is an anthropologist, geographer and public intellectual and is recognised internationally for her ground-breaking work modernising the mining industry's engagement with Indigenous people, particularly in the difficult area of negotiating and settling agreements.

FOREIGN FELLOW

Distinguished Professor Menachem Elimelech FTSE
Sterling Professor of Chemical and Environmental Engineering, Yale University

Distinguished Professor Menachem Elimelech is an acclaimed environmental engineer, widely known for his work addressing the global water crisis.

NEW FELLOWS 2022

The new ATSE Fellows for 2022 will be announced at ATSE's inaugural symposium: ACTIVATE in Sydney on 26 October 2022.

To find out more and to register:
atse.org.au/activate

Budj Bim Cultural Lanscape on Gunditjmara Country, south-west Victoria. Image source: budjbim.com.au

Decolonising STEM

In her 2021 New Fellows Address, Honorary Fellow Distinguished Professor Marcia Langton explored why we need to acknowledge and celebrate Indigenous science, technology, and engineering.

Distinguished Professor Marcia Langton
AO FASSA FTSE

An Associate Provost at the University of Melbourne, Marcia Langton is an anthropologist, geographer and public intellectual. She is recognised internationally for her ground-breaking work modernising the mining industry's engagement with Indigenous people, particularly in the difficult area of negotiating and settling agreements.

I pay tribute to the Wurundjeri Traditional Owners and their Elders, past and present. I live and work on their country and enjoy the fruits of their long and hard struggle for First Nation's rights and dignity, and for recognition and a treaty.

I am honoured by the invitation to join the Australian Academy of Technology and Engineering as an Honorary Fellow.

I grew up in Queensland when being Aboriginal was essentially a crime. The legislation governing our lives was a draconian hangover from the nineteenth century frontier.

As a descendent of the Yiman people of Central Queensland, I became curious about the history of my people, and undertook a life of study and research to answer questions about Australia's past. That body of questions has grown and grown over the decades.

As an engaged anthropologist and geographer conducting research in Indigenous Australia, the challenge of having Aboriginal and Torres Strait Islander knowledge systems recognised has become a central theme of my work.

I believe this challenge is of great relevance to the Fellows of the Academy, and all people who hope for a flourishing, sustainable future.

60,000 YEARS OF SCIENCE

For over two hundred years, Indigenous Australians have hosted and guided scientists and scientific expeditions seeking to understand the environments, flora, fauna, and climate of this continent, as well as the cultures of the Indigenous peoples themselves.

Aboriginal knowledge and science have contributed to our understanding of the shape of Australia, and the remarkable changes that occurred when the seas rose following the last ice age seven thousand years ago.

Such collaborations between Aboriginal people and scientists have produced many rich and detailed pictures of the ancient past. This has resulted in a vast literature on Australian life.

But until recently, much of it was read only by the experts.

Some scientists and researchers have recognised the importance of these traditions and their relevance, especially in relation to understanding and living with our environments and climate.

There is also greater respect today for the Aboriginal and Torres Strait Islander people who manage land and water. Scientists and others are often involved in research projects to help protect these environments and to find ways to make our traditions applicable to the much-changed landscapes of today.

Despite the terrible impact of colonialism and subsequent policies, our survival owes much to our traditions of science and ability to adapt to new technologies and social and economic threats.

One of our greatest successes has been to preserve our land management and cultural traditions by insisting that we have a right to do so. Now, there is much to share, and it is best learned from the Indigenous stewards of this land.

We are the descendants of the first people to come here, sixty millennia ago. Our history represents a fifth of the total of human history, and the evidence of it should be regarded as a world cultural and scientific treasure.

CULTURAL BURNING: TRADITION AND TECHNOLOGY

Our knowledge systems are of great relevance to humanity's present dilemmas. One striking instance of this is cultural burning.

Cultural burning encompasses social and scientific Aboriginal traditions of fire use as a technology to shape environments and to quell wildfires.

In the Australian 2019-2020 summer, wildfires exploded in the forests and scrublands with deadly and devastating consequences for the people, wildlife, and environments in their paths.

For some species, this was the tipping point. More have become endangered. Australian extinction rates were already among the highest in the world before the black summer.

Britain's colonisation of Australia is directly correlated with species extinction, in a broad sequential wave beginning from the first settled areas in South-eastern Australia, to the present day in much of Northern Australia. Quashing Indigenous land management, particularly the use of fire, worsened the losses.

Now those losses are accelerating.

In early 2020, the Australian government established the Royal Commission into National Disaster Arrangements to enquire into the potential for Australian governments to better coordinate their responses to limit the deadly and destructing impacts of bushfires.

Cultural burning provides a part of the solution to this ongoing disaster, as the Royal Commission found. The Royal Commission report is an impressive document containing eighty recommendations.

In its recommendations, the Commission urged that Australian state, territory and local governments should engage further with Traditional Owners to explore the relationship between Indigenous land and fire management and natural disaster resilience.

And they should explore further opportunities to leverage Indigenous land and fire insights in the development, planning and execution of public land management activities. These recommendations were based on evidence from across the country.

WONDERS OF THE WORLD

Another example of Indigenous engineering and technological skills is now acknowledged by UNESCO and inscribed on the World Heritage List.

Budj Bim is an Aboriginal cultural heritage landscape in south-west Victoria. It is the home of the Gunditjmara people, who have managed this remarkable environment for thousands of years. Their land management agency, Gunditj Mirring has developed a master plan for this landscape and nominated it to the UNESCO's World Heritage Listing.

They are the only Indigenous people in the world to successfully nominate a highly valued part of their country to this listing, citing the cultural values of their Budj Bim cultural landscape. The landscape was created by volcanic lava flow from Budj Bim, that erupted thirty-seven thousand years ago leaving a rugged terrain of basalt rises, swampy depressions and waterways.

The Gunditjmara manipulated this volcanic landscape that extends from Budj Bim to the sea and encompasses a series of waterways, including Lake Condah and the Fitzroy River. From at least six-and-a-half thousand years ago, the evidence shows that they engineered the volcanic lava flow from the eruption.

They built the oldest and largest aquaculture system in the world. They managed and harvested the short-finned eels whose migratory route bring them to this region each year, creating an economy and culture that thrived with the great natural wealth that they harnessed.

They built houses with stone walls at their base and permanent settlements arranged in family groups along the waterways and channels and expanded them in each generation. A rich water world of engineered channels, ponds and villages has been passed down for centuries.

Elsewhere in Aboriginal Australia, other groups of Aboriginal Traditional Owners are maintaining our natural and cultural heritage.

CLOSING THE DATA GAP

We need to close the gap on the high levels of Indigenous disadvantage across all socio-economic indicators of health, wellbeing and the capabilities necessary for participation in our society and economy.

We must draw on the lessons of history to understand how these extreme levels of disadvantage came about. That means we need good information. I am convinced that

Budj Bim Cultural Landscape on Gunditjmara Country demonstrates how Gunditjmara people worked with the natural resources and environment of the Victorian south west region to establish a permanent place of human society over the past 30,000 years and beyond. Image source: budjbim.com.au

data-driven decision making is a key solution to several major challenges.

Data use and Indigenous data governance, by and for Aboriginal and Torres Strait Islander people, in a range of fields including health and wellbeing, incarceration and education, have become a core subject of my work.

Indigenous people have built a body of data assets through our development of community-controlled corporations that deliver services to our populations. Drawing on my anthropological training and long interest in our history, and in my associations with demographers and others in the STEM community, I have learnt that Indigenous data sovereignty and data governance are essential to progress the challenges that we face, and to advance the lives of all Australians.

In less than two years, during the COVID-19 pandemic, we have become aware of the power of data as never before.

We owe our good fortune in escaping the death rates experienced in other countries to the scientific expertise wielded to measure and shape responses to the shocking global threat to the health and wellbeing of humanity. The response of the Australian governments to the COVID-19 pandemic has involved daily reporting of data.

This data has been used to manage the spread of the virus and the pathway to a highly vaccinated populous. Australian governments have demonstrated overall competence and capability in confronting and dealing with the worst pandemic in a hundred years.

Imagine if the governmental power and the scientific and medical expertise brought to bear during this pandemic were mobilised to address the other existential threats to humanity: the climate crisis, species extinction, pollution, poverty and injustice.

The response of the First Nation's health sector to the pandemic has been remarkable. Professor Fiona Stanley has noted that they not only prevented hundreds of cases and saved many lives — they also avoided significant hospital and intensive care costs. This response, she said, is the best of any Indigenous group in the world, with many others having devastating outcomes. And more importantly, Professor Stanley raised the question, how did they do it? The Aboriginal community-controlled health services swung into action across the country. There was outstanding health professional and organisational leadership that rapidly implemented best practice across all Aboriginal community-controlled health and welfare organisations.

With their public health training, they knew exactly what they had to do to protect communities and to manage the disease if it occurred. This was done by setting up trusted collaborations with relevant state, territory, and federal government departments to provide advice on all aspects of the pandemic response. This response deserves close analysis to guide future policies and practices.

My goal is to ensure that curricula across our education sector incorporates Indigenous knowledge and informs Australians of the relevance of this ancestral legacy to our society today.

By developing new courses of study at universities and ensuring the inclusion of Indigenous students, I have hope to achieve recognition of education's critical role in Aboriginal cultural survival.

I hope you will join me in these endeavours.

MORE

Keynote address
Watch Distinguished Professor Langton's moving keynore address at: atse.org.au/keynote-addresses/2021-marcia-langton

Submissions from the Academy

Medical Research Future Fund (MRFF) Australian medical research and Innovation strategy and priorities consultation

OCTOBER 2021

Our submission recommended that the Australian Medical Research Advisory Board seizes this opportunity to develop a new strategy and priorities to invest in significant innovation in areas where this can deliver the best value to improve the health of Australians.

We recommended that the Medical Research Future Fund's outcome and impact evaluations are transparent and fit-for-purpose and should continue to prioritise monitoring and evaluation. This included specific recommendations to add or renew focus on key areas including:

- climate change impacts
- women's health
- future health services
- Aboriginal and Torres Strait Islander health.

Higher Education Research Commercialisation (HERC) Intellectual Property Framework consultation paper

OCTOBER 2021

Our submission to the Department of Education, Skills and Employment's HERC IP Framework consultation agreed that an IP Framework could support early career researchers and small to medium enterprises to enter into commercialisation agreements with partners, and could help investors see the potential returns on their investments.

However, we cautioned that the huge variety in circumstances between each commercialisation collaboration means a standard set of agreement templates in a framework are unlikely to be robust and flexible enough to be broadly useful for most partnerships.

We therefore recommended that the scheme should more flexibly support the development of IP agreements, including through educative initiatives, providing guidelines, and developing of pre-negotiation tools.

National Research Infrastructure Roadmap

DECEMBER 2021

Our submission on the National Research Infrastructure Roadmap consultation commended the draft roadmap, particularly the inclusion of humanities and social sciences in the ethical development and implementation of new and emerging technologies.

We recommended strengthening the draft Roadmap by:

- providing continuity and long-term funding to the national research infrastructure
- implementing a greater focus on data linkage and re-use
- considering the future national research infrastructure workforce
- recognising the value of Indigenous knowledge and engagement.

Low Emissions Technology Statement 2022 consultation

FEBRUARY 2022

Our submission to the 2022 Low Emissions Technology Statement welcomed the commitment to net zero emissions by 2050 and recommended a more ambitious interim emissions target by 2030.

Our key recommendations included:

- adding a filter for likelihood of technology reaching maturity by 2030
- prioritising a rapid transition to renewable energy and energy storage
- continuing to invest in curiosity-driven research
- developing the future STEM workforce
- using the regulatory environment to incentivise renewable energy uptake.

Australia needs a budget for a technology-powered, human- driven future

FEBRUARY 2022

Our 2022 pre-budget submission outlined the need to develop a skilled workforce for the future, create the conditions for research activity and commercialisation, and use technology to address climate change.

To achieve this vision, our submission recommended that the government:

- deploys national programs to develop digital literacy and encourage STEM careers
- develops the STEM teaching workforce
- enhances industry opportunities for early-career researchers
- delivers a comprehensive research funding strategy
- fully funds the University Research Commercialisation Scheme
- invests in electric and hydrogen vehicle infrastructure.

Australian Research Council Amendment (Ensuring Research Independence) Bill 2018 consultation

MARCH 2022

The Australian Research Council Amendment (Ensuring Research Independence) Bill 2018 concerned the ministerial veto for Australian Research Council (ARC) funding outcomes. Our submission expressed concern about the recent application of the ministerial veto without clear and detailed reasons.

The submission highlighted the importance of upholding national interest in research, promoting confidence in the research funding system, and safeguarding national security.

Higher Education Research Commercialisation (HERC) Intellectual Property (IP) Framework templates further consultation

MARCH 2022

Our March submission built on earlier contributions to the HERC consultation to argue that the IP templates should be an optional resource, rather than a compulsory requirement for large funding programs.

We also recommended:

- maintaining a publicly available registry of university-industry IP agreements
- providing information on best practices for Indigenous knowledge
- developing supplementary optional resources to help collaborators build partnerships and understand IP.

Excellence in Research for Australia (ERA) 2023 — preprints consultation

MARCH 2022

Our submission on the inclusion of preprints in Excellence in Research for Australia (ERA) outlined the importance of upholding peer review as the gold standard in assessing the quality of research. We therefore recommended not to include preprints in ERA 2023.

Our submission also highlighted key recommendations from earlier ATSE submissions on ERA, such as lengthening the reference period of ERA and providing open access to ERA evaluation data and metadata.

Respect@Work — Consultation on remaining legislative recommendations

MARCH 2022

Our submission on the six remaining legislative recommendations on the Respect@Work report contended that all recommendations of the Respect@Work report should be implemented in full.

This would support the STEM sector to create more inclusive workplaces, in particular addressing barriers to women participating and advancing in the workforce.

Our submission focused on how workplaces can be supported to meet positive duty obligations that would be created under the legislative recommendations, using our Diversity & Inclusion Toolkit as a good practice example.

Australia's productivity performance consultation

MARCH 2022

Our submission to the Productivity Commission's consultation on Australia's lagging productivity performance recommended a three-pronged approach to lifting productivity through targeting STEM education, research and development, and digital infrastructure.

Recommendations included increased public investment in:

- educational programs for STEM skill development in the current and future workforce
- research and development (including research translation)
- facilitating of knowledge-based capital.

National Biosecurity Strategy consultation

MARCH 2022

Our submission to the Department of Agriculture, Water and the Environment's consultation on the draft National Biosecurity Strategy endorsed the Strategy's priority areas, discussed challenges for the biosecurity workforce, and proposed the inclusion of One Health and Traditional Knowledge in understanding biosecurity.

ERA 2023 benchmarking and rating scale consultation

APRIL 2022

Our submission to the Australian Research Council's consultation on the methodology for Excellence in Research for Australia (ERA) proposed a more granular rating scale, endorsed the inclusion of the two new citation metrics, and considered the broader issues in defining world standards for the purposes of the ERA.

Automated decision making and AI regulation consultation

APRIL 2022

Our submission to the Department of Prime Minister and Cabinet's Digital Technology Taskforce's consultation on automated decision making (ADM) and artificial intelligence (AI) regulation proposed solutions for developing capabilities and public trust. Recommendations included:

- Regulating the use of data sets in AI and ADM development
- Introducing accountability and transparency requirements for government agencies using ADM
- Increasing public investment in research and development to secure future AI and ADM innovation
- Investing in high-speed internet as supporting infrastructure for AI and ADM
- Implementing programs to increase the size of the digitally skilled workforce
- Increasing employment and retention of underrepresented groups in the AI workforce

Research Block Grant reform consultation

MAY 2022

Our submission to the Department of Education, Skills and Employment's consultation on proposed reforms to the Research Block Grant (RBG) funding framework considered the purpose and possible impact of the reforms. The submission recommended rejecting the proposed changes, increasing flexible funding for basic research, and using other methods to incentivise industry investment in research and development.

MORE

Details
Read our recent submissions online at atse.org.au/research-and-policy/publications

Six facts (& myths) about energy decarbonisation

From violent firestorms to catastrophic floods, recent events in Australia reaffirm that we're already feeling the impacts of climate change.

Unfortunately, this trend of volatile weather is set to worsen, and the world will experience more frequent natural disasters in the coming decades.

Worryingly, even with significant global commitments to reducing emissions, the recent Intergovernmental Panel on Climate Change report makes it abundantly clear that hopes of restricting global warming to 1.5 degrees look increasingly unlikely.

To prevent the deadliest consequences of climate change we must decarbonise the whole economy. This will require an energy transition atf a scale never seen before.

Transitioning to renewable energy will be a complicated endeavour, partly because in many regions of the world political ideologies and vested interests have delayed or prevented the development of holistic and realistic energy transition plans.

In 2022, there is still much myth and misinformation about what decarbonising our energy system means. To tackle the threat of climate change and seize this historic opportunity, we need to look at the evidence base and separate fact from fiction.

1. FACT

Our energy future will be renewable and decentralised

As we inevitably phase out fossil-fuels across the economy, our electricity system will produce most of our energy — through renewables. The rapidly decreasing costs of renewable energy technology is driving Australia towards an energy system powered by centralised, utility-scale wind and solar, and decentralised photovoltaic systems.

Evidence from the CSIRO shows that renewables are already the cheapest way for new power plants to make electricity. They'll get even cheaper in the decades ahead.

When it comes to distributed generation, Australia has the highest per capita adoption of solar panels anywhere in the world.

Currently, around three million homes in Australia have rooftop solar. That means in some parts of our grid, one in three homes are already being powered by the sun.

While these trends in renewable adoption aren't exclusive to Australia, they are happening here faster than almost anywhere else in the world.

The latest modelling from the Australian Energy Market Operator Integrated System Plan shows that over the next 30 year, renewable and distributed energy generation will become our main energy source.

2. FACT

We can run the grid without burning fossil fuels

While innovation will continue to improve the efficiency and price of renewables, the technology we need to produce 100 per cent of our energy without fossil fuels already exists today.

One false but persistent myth about the energy transition is that we'll always need to keep burning some coal, oil, or gas for something called 'baseload power'.

In reality, the term 'baseload' refers to an outdated historical mechanism for dealing with the inherent inefficiency of burning coal.

Coal-fired power stations are inflexible: it's hard to reduce their output when people need less energy,

Professor Lachlan Blackhall
FTSE

Professor Lachlan Blackhall is Entrepreneurial Fellow and Head, Battery Storage and Grid Integration Program at The Australian National University. Professor Blackhall holds a BE, BSc, and a PhD in engineering and applied mathematics, is a Senior Member of the Institute of Electrical and Electronics Engineers (IEEE) and a Fellow of both the Institution of Engineers Australia (IEAust) and ATSE. In 2015 Lachlan won ATSE's Batterham Medal for Engineering Excellence

such as overnight. Baseload isn't about energy supply, it's the minimum energy demand you need to continuously run a coal plant.

In contrast, it is true that to operate an electricity grid, you need to make sure you have both energy reliability and energy security.

Energy reliability means that we have enough electricity supply to meet the grid's demand at any point in time.

Energy security means that we can keep the electricity system working when there's a disruption, like a generator outage or a transmission line going down.

Under the current way our grid operates, energy security requires both inertia and system strength.

Inertia is required to maintain a stable frequency as as energy supply and demand fluctuates.

System strength is the electricity system's ability to maintain the right voltage waveforms, which makes the grid more resilient to disturbances.

Historically, fossil fuel fired generators have been a source of both inertia and system strength. But they're definitely not the only source.

We can supply both inertia and system strength with other assets that don't contribute to carbon dioxide emissions, most notably with energy storage technology.

3. FACT

Energy storage will get better, cheaper, and more widespread

In a renewable and distributed power system, we'll need to store energy to make it reliable and secure. Electrical energy will be stored with pumped hydro (like the currently under-construction Snowy 2.0) and in different kinds of batteries.

Battery storage will be installed throughout the electricity system at various scales. Residential and neighbourhood batteries will be spread throughout the electricity distribution network.

Meanwhile, bigger battery systems will store energy from utility-scale wind and solar plants directly via 'transmission connection' and will usually be located near these renewable generators.

Electric vehicles also represent a significant amount of battery storage — they're grid-connected batteries on wheels. If every petrol car in Australia was replaced with an electric one, it would provide an energy storage 'asset' with more than five times the storage capacity of Snowy 2.0.

Energy storage won't just be electrical. Both residential and commercial applications will also take advantage of thermal storage in the form of hot water heaters and boilers.

4. FACT

The transition won't be led by technology alone

All this talk of energy generation and storage assets might lead us to believe that this will be a purely 'technology-led' energy transition.

But while technology is important, decarbonising our power system is a complex socio-techno-economic challenge. We need a deep understanding of the social and economic dimensions of the transition as well as the technical ones.

For example, current models of distributed solar photovoltaic panels and residential battery adoption heavily favour people and households who can afford these new technologies and own their own homes.

Vulnerable customers, renters and apartment dwellers urgently need new models of ownership and use to benefit from the uptake of these new technologies.

As we wind down the fossil fuel industry, we also need to support and retrain the large number of people it currently employs to make sure this transition is socially and economically just.

Fortunately, energy decarbonisation will create many more skilled, well-paying jobs — especially if we harness Australia's abundant renewable resources to become a renewable energy export powerhouse.

5. FACT

We need to integrate all parts of the energy system

Our future energy system will be largely electric. However, electrification alone is only one piece of the puzzle.

The key to effective decarbonisation will be integrating new generation, storage, and transportation technologies into our energy system.

Integration will involve finding and using tools that allow these new technologies to talk to each other and work together.

These new integration capabilities include new systems, new algorithms, and even new technical standards — an often forgotten but vitally important contributor to beneficial integration outcomes. Effective integration will ensure that these technologies work together to underpin energy reliability and energy security.

In the same way that the convergence of communications led to the internet being called the information superhighway, the integration of these technologies into our electricity system will make it the 'electricity superhighway' of the future.

This electricity superhighway will underpin our energy transition and ensure that we sustainably decarbonise the whole economy.

Effectively integrating all these technologies into our electricity system will also enable more resilient infrastructure and communities.

Renewable and distributed energy generation and storage can underpin microgrids and neighbourhood energy systems that ensure communities continue to have access to energy during volatile weather and natural disasters.

To achieve both our decarbonisation and resilience goals, we must ensure that we 'integrate everything'!

In a renewable and distributed power system, we'll need to store energy to make it reliable and secure. Electrical energy will be stored with pumped hydro (like the currently under-construction Snowy 2.0)

6. FACT

We need to stop burning gas (and hydrogen can help us do it)

Perhaps the most important unresolved questions about our energy transition involve the roles of gas and hydrogen.

Fossil gas is sometimes referred to as a transition fuel because of an inaccurate perception that it's cleaner than coal.

But while gas emits somewhat less carbon per unit of energy produced at the point of generation (just over half as much as coal) these emissions are still dangerously changing the climate.

Furthermore, the gas supply chain emits uncaptured methane: a potent greenhouse gas which captures heat in the atmosphere at approximately 25 times the rate of carbon dioxide.

To rapidly achieve our decarbonisation targets, it's vital that we eliminate the use of gas in our energy system as quickly as possible.

Replacing gas is one of the reasons why people are getting excited about opportunities for green hydrogen. Unlike brown and blue hydrogen, which still emit significant amounts of carbon dioxide, green hydrogen is typically produced from the electrolysis of water with energy from renewable sources like solar and wind.

Current evidence suggests that most Australian-produced hydrogen will be exported, with countries including Japan and South Korea signalling that in coming decades they're looking to decarbonise their economies through the significant uptake of green hydrogen.

The use of hydrogen in Australia will probably be limited to inputs for industrial processes and in difficult-to-decarbonise sectors like long-haul transport.

Fully exploring the potential of a hydrogen economy in Australia is only just starting.However, the opportunities for hydrogen could be literally sky high. For example, Airbus recently announced a demonstration program to explore the potential for hydrogen powered aircraft.

Will Australia be a renewable energy export powerhouse?

According to the International Energy Agency's recent report *Net Zero by 2050: A Roadmap for the Global Energy Sector*, all countries need to immediately implement a broad range of new policy approaches and technologies to decarbonise their energy systems and cut carbon emissions to net zero by 2050.

Professor John Söderbaum
FTSE

Professor John Söderbaum is a scientist with over 40 years of policy and program experience. His work includes energy, climate change, R&D, innovation and industry development. John works at the interface of the public, private and research sectors and believes collaboration between all these sectors is an important driver of innovation and productivity.

Wind turbines, Albany WA

ENERGY

As a traditional fossil fuel exporter, this is both a risk and an opportunity for Australia's energy exports, tax revenue and employment.

Fossil fuels make up around a quarter of our total exports. However, four of our top five trade partners (Japan, South Korea, the United States, and the United Kingdom) have all set 2050 net zero targets, and the fifth, China, is aiming for 2060.

These countries have all introduced policies and projects to help them achieve this goal. Given that China, Japan, and South Korea receive two thirds of our fossil fuel exports, the market for Australian coal and gas is likely to substantially decline.

A WORLD OF OPPORTUNITIES

Fortunately, Australia has much to offer in the development of a net zero emissions world. We have a vast capacity to generate solar and wind electricity, which we could export through undersea cables or in the form of green hydrogen or ammonia.

We can also use renewable energy to produce energy-intensive commodities such as steel and aluminium.

In addition, Australia has large deposits of the critical minerals needed to manufacture clean energy technologies such as lithium-ion batteries, wind turbines and solar photovoltaic cells.

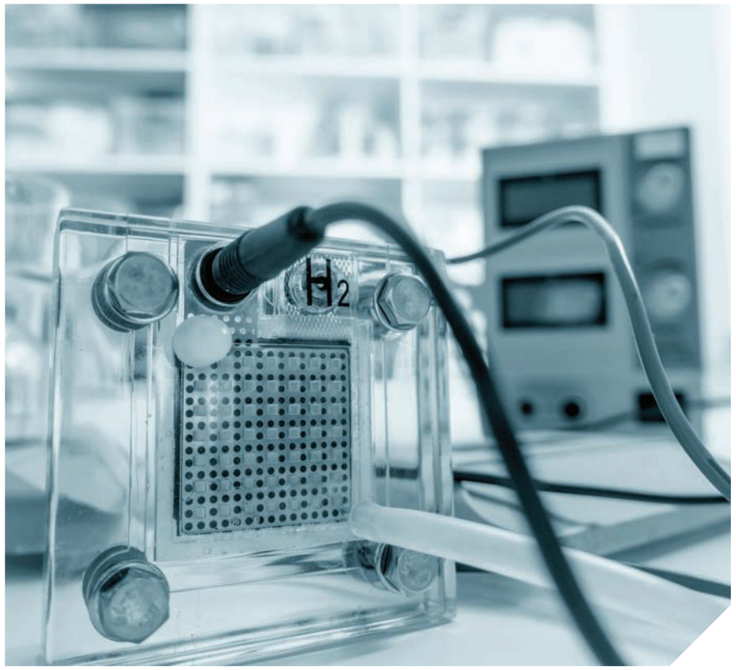
Lastly, we have a highly capable workforce, with the experience and skills to deliver large scale and capital-intensive projects. Each of these opportunities are explored below.

SHARING OUR SUNSHINE

Australia's size and natural solar and wind resources mean we can produce vast zero emissions (or green) electricity.

We could potentially export this energy to our regional neighbours through high-voltage direct current cables.

Innovators and investors are already exploring this approach. Sun Cable's proposed Australia-Asia PowerLink would supply renewable electricity to both Darwin and Singapore.



Sun Cable aims to build the world's largest solar farm and battery storage facility in the Northern Territory, with between 36-42 gigawatt hours of battery storage: enough to power 300,000 average Australian homes for a week.

This energy will then be exported to Singapore via 4,200 kilometres of submarine cables.

Singapore currently relies on gas for approximately 95 per cent of its electricity generation. The PowerLink project aims to meet up to 15 per cent of Singapore's annual electricity demand with emission-free energy, diversifying Singapore's electricity network and slashing its carbon emissions.

The initiative will also create thousands of jobs for Australians and help us become a renewable export powerhouse.

If Sun Cable's project is successful, it will encourage additional investment in large scale, renewable export projects in Australia and help our regional neighbours who need cheap, clean, and reliable energy sources.

THE HYDROGEN BOOM

Hydrogen can be used as an alternative to natural gas and crude oil in sectors that aren't easily electrified. We can also use it to produce green ammonia, an important feedstock for chemical fertiliser.

Green hydrogen is made by using renewable electricity to split water, a process which doesn't emit any CO_2. As green hydrogen gets cheaper to manufacture, it will increasingly displace fossil fuels and non-renewable hydrogen made from fossil fuels with or without Carbon Capture Utilisation and Storage (CCUS).

Japan, South Korea, and Germany, for example, all intend green hydrogen to play an important role in meeting their net zero by 2050 targets.

Australia's growing capacity to generate cheap, clean energy, and our strategic location in the Asia-Pacific region, make green hydrogen an excellent potential export opportunity.

Other countries recognise this, and we have a growing number of bilateral hydrogen initiatives, including:

- the Australia-Japan Joint Statement of Cooperation on Hydrogen and Fuel Cells
- the Letter of Intent for Hydrogen Cooperation between Australia and South Korea
- the German-Australian Hydrogen Innovation and Technology Incubator.

The Federal Government has also conditionally approved the development and funding of three green hydrogen generation plants to further support this new sector.

ATCO Australia and Australian Gas Infrastructure Group will use 10 megawatt electrolysers to produce green hydrogen for gas blending, while Engie Renewables will use 10 megawatt electrolysers to produce green hydrogen to use as feedstock in green ammonia production.

GREEN MINING

The clean energy technologies we need to decarbonise the global energy system — such as lithium ion batteries, wind turbines and solar photovoltaics — require large amounts of several critical minerals to produce.

For example, battery technology relies on a steady supply of lithium, nickel, and manganese. Global demand for these critical minerals is expected to soar in the coming decades, particularly in countries such as South Korea, Indonesia, and Thailand, which have outlined plans to become world-leading battery manufacturers.

Mining critical minerals is a significant market opportunity for Australia. We have an abundance of many of these resources, including some of the largest reserves of lithium, copper, nickel, and cobalt in the world.

Australia also has reputation as a low-risk jurisdiction for mining investment, an ability to electrify many mining and refining processes, and close proximity to major technology producers in Asia.

These factors make us well placed to supply this exponentially growing demand and become a key exporter of critical minerals.

KNOWING THE COMPETITION

While the shift towards a renewable energy future is an exciting export opportunity for Australia, there are also challenges we need to overcome.

It's important to recognise that Australia is competing for investment in a global market. Competitor nations in the renewable energy export space include Chile and China, which are both well on their way to developing a renewable energy export industry.

As an example, China currently provides three-quarters of the world's rare earth elements (which are essential in manufacturing renewable energy technologies) and is responsible for most of the world's critical mineral processing.

This, coupled with cheap labour and generous government subsidies gives China a competitive advantage in renewable technology manufacturing — for instance, it produces 80 per cent of the global supply of solar photovoltaic modules.

The growing economies of scale in Chinese supply chains make it hard for Australia to compete on price.

However, other factors such as sustainability of production and reliability of supply may be important positives for Australia.

TECHNOLOGY CHALLENGES

While innovation has come a long way, we also still have barriers to be overcome in several clean energy technologies, particularly with regard to hydrogen. Currently, most hydrogen produced globally is 'grey', meaning it is made by burning gas (methane) without attempting to capture the greenhouse gases made in the process.

Grey hydrogen production is responsible for about 2.5 per cent of annual global CO_2 emissions and significantly contributes to global warming.

Adding CCUS to hydrogen produced from methane is called 'blue hydrogen'. This would drastically reduce carbon emissions.

However, there is currently no significant commercially viable CCUS in operation because the technology is too expensive.

We also need to improve the efficiency of producing green hydrogen and reduce the cost of renewable energy to achieve the $2 per kg green hydrogen targets set by the Federal Government.

Finally, we need high levels of capital investment in hydrogen distribution.

Regional electricity exports such as the Sun Cable project also face technological challenges — particularly in high voltage direct current cabling, which is presently extremely expensive. The offshore wind sector is also navigating this challenge.

A RENEWABLE FUTURE

The cost of renewable energy generation continues to get cheaper, and investment in the sector is now largely de-risked.

We can expect this to motivate the direct electrification of transport, heating, and industrial processes in Australia.

The resulting lower energy costs will benefit communities, businesses, and manufacturers.

If we work to our strengths and harness our abundant solar and wind resources, and wealth of critical minerals, Australia is well placed to extend this benefit to the export sector and become a renewable powerhouse in our region.

What's the dirt on soil carbon?

Is capturing carbon in farm soil a practical way to help us reach net zero emissions?

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Every farmer, ecologist and good gardener knows how important organic matter is for soil.

High levels of plant litter, roots, soil fauna and microorganisms keep soils healthy with good structure and function.

Many farmers in Australia already do things to improve soil health, such as growing cover crops, applying compost or manure, and using no-tillage — a technique for leaving soil undisturbed which is used on about two-thirds of cropland in Australia.

Different organisations are now looking at practices such as these as a strategy to mitigate climate change. But their real contribution to achieving net-zero targets and reducing global warming is much less certain.

WHAT IS SOIL CARBON?

Around 58 per cent of the organic matter in soils is carbon.

Scientists estimate that 1500 to 2000 billion tonnes of carbon are stored in the top metre of the world's soil. Two to three times more carbon is stored in soil than in the atmosphere and all vegetation combined.

Soil organic carbon begins as atmospheric carbon dioxide which plants take up through photosynthesis. The carbon then enters the soil in the form of decomposing plant material, compounds secreted by roots and soil organisms.

Building up organic carbon in soil is attracting increasing attention as a way to improve soil health while decreasing carbon dioxide in the atmosphere.

Australia's Long-term *2050 Net Zero Plan* includes storing more carbon in soil (for a nominal period of 100 years) to offset some of our greenhouse gas emissions. This plan aims to support our Paris Agreement commitment to emit, on net, no greenhouse gas by the middle of this century.

Increasingly, individual companies and industries setting their own net-zero targets are also banking on a contribution from soil carbon offsets.

WHAT ARE SOIL CARBON OFFSETS?

Soil carbon offsets are measures of the amount of carbon from carbon dioxide locked away in the soil. They're monitored under Australia's Emissions Reduction Fund, which has outlined specific rules to measure how much more organic carbon is stored in a standard mass of soil.

Only carbon in organic matter less than 2mm in diameter is counted, so offsets don't include larger roots and litter fragments. Offsets also exclude inorganic carbon, which is mostly found in carbonate minerals.

Organic carbon exists in different chemical and physical forms that decompose at different rates. The balance between inputs and outputs determines whether soil is gaining or losing carbon at any given time.

Micro-organisms readily decompose as much as 90 per cent of the organic residues added to soil and release the carbon as carbon dioxide. This process provides nutrients for plant growth and energy for the microorganisms. But while this is important for healthy soils and vegetation, it leaves only a small percentage of carbon available for long-term storage in stable forms, commonly called humus, and also some charcoal from historical burning.

This is the basis of sequestration. So, if a farmer adopts a new practice like adding more organic residues to cropping soil, sequestered soil carbon will probably only increase slowly, over years or even decades.

HOW MUCH CARBON CAN WE STORE IN THE SOIL?

It isn't easy to predict how much soil carbon we can sequester at a location like a farm, for multiple reasons.

Soil processes are complex, and the dynamics and persistence of organic carbon vary across the range of climate zones, soil characteristics and agricultural productivity.

Research also shows that global warming itself may impact storage. For example, modelling by the New South Wales Government suggests that climate change could cause significant declines in soil health and soil organic carbon in state forest lands as soon as 2040.

There also haven't been enough long-term trials to give us sound evidence that the land management practices proposed to improve sequestration are effective and economically viable.

Other overarching barriers to better estimating farmland sequestration are that we don't have enough good data on current levels of carbon across agricultural soils, and high costs limit our capacity to accurately measure changes due to management practices. Currently, reliable measurement requires sampling and laboratory analysis that are costly and time-consuming.

Recent investment and global cooperation to develop more cost-effective methods with suitable accuracy are starting to show promising results. These include spectroscopic (the study of the absorption and emission of light) and modelling techniques. But unfortunately, they aren't widely available for use yet.

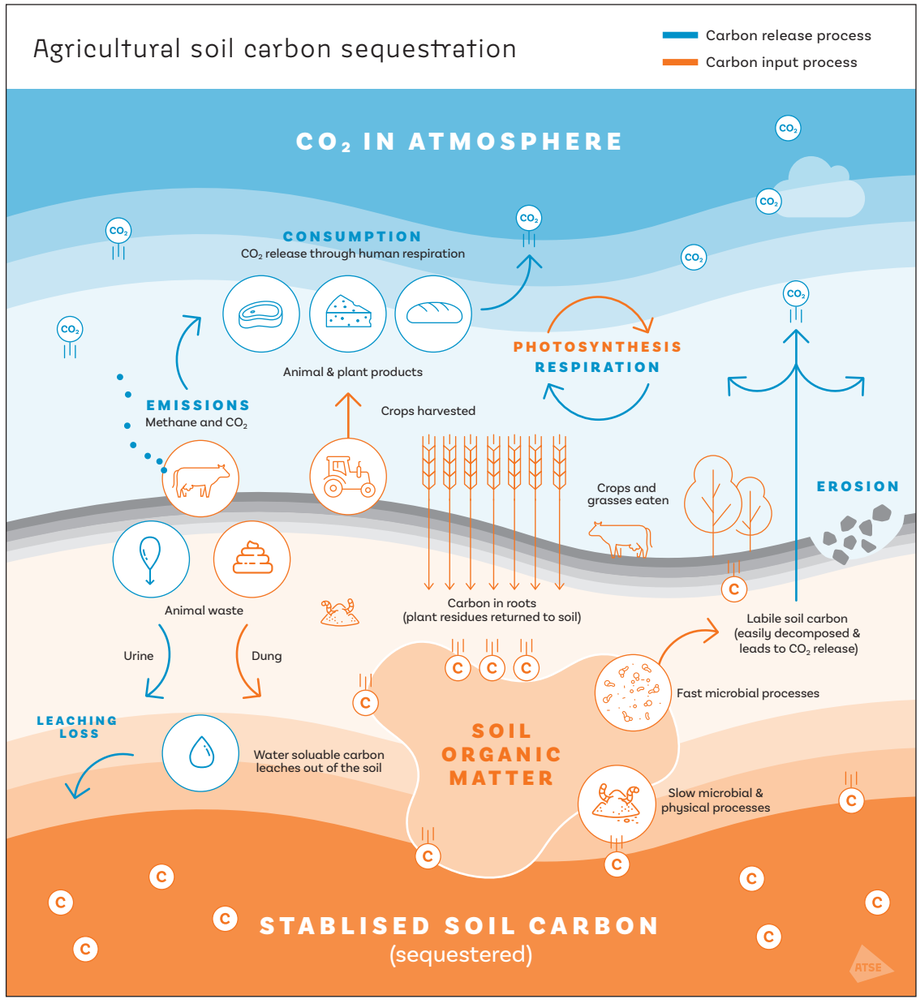
HOW MUCH WILL SEQUESTRATION AFFECT CLIMATE CHANGE?

Predicting how much soil carbon we can sequester at a farm or project scale is already complex. But extrapolating local estimates to work out how much soil carbon is impacting our climate change mitigation targets at a national or even global level is even more challenging.

Research and experience show it's possible to build soil carbon in certain crop and pasture lands. But significant uncertainties in the data and assumptions for scaling-up that sequestration limit how confidently we can estimate what soil carbon offsets could achieve for our net-zero targets.

Soil and climate characteristics and management systems vary enormously across Australia, and this influences how much carbon we can store and how quickly it will change.

At any site, rainfall and temperature, and then soil factors, largely determine the maximum potential soil carbon content.



Carbon is continuously added to and released from the soil through a range of complex processes. Changing land management practices can change the amount of carbon stored or released. (Source: ATSE Explainer: Australia's Soil Carbon Opportunities and Risks)

Moist, cool environments and clay-rich soils support higher organic carbon levels. More arid regions with high seasonal variability and sandy or nutrient-poor soils, particularly with low nitrogen and phosphorus, can't store as much carbon.

But it's not just average rainfall that affects the rate and direction of change in soil carbon — the variability of rainfall does too. One Australian study estimated that 12 years of increase could be reversed in three years of drought, which of course slows net long-term gain.

Sequestration also generally slows over time, because after farmers implement a new practice, the system will eventually approach a new steady state.

ARE THERE OTHER CHALLENGES?

Local conditions influence which practices will be most effective for improving soil health. But this may not necessarily equate to higher carbon sequestration or more carbon credit units. Generally, soils with a high clay content have a higher sequestration potential.

For example, farmers can overcome a nitrogen deficiency by using fertiliser or planting legumes. But this may increase emissions of nitrous oxide (a strong greenhouse gas) and reduce how much the increased carbon stored in soil reduces global warming.

There are few long-term field studies in Australia to help us understand the factors affecting soil carbon sequestration and improve our confidence in scaling up these processes to inform policy development.

A CSIRO review of data from multiple studies published in 2010 shows that many farmlands are unlikely to return high rates of sequestration over decadal periods.

For example, across extensive grazing land the average annual sequestration rate in the top 30cm of soil was estimated to be between 0.1 to 0.3 tonnes of carbon per hectare (equivalent to removing 0.37 to 1.2 tonnes of carbon dioxide from the atmosphere each year in each hectare).

Since colonisation, settlers converting natural environments to western-style farmland has reduced Australian soil carbon stocks by 20 to 70 per cent. Overcoming this deficit with practices that store more organic matter would theoretically greatly benefit our efforts to alleviate climate change.

However, economic and social constraints on adopting and implementing these practices, as well as biological and physical factors, mean that the realistic potential is much less than the technical potential; possibly only 10 to 30 per cent.

IS SOIL CARBON THE ANSWER?

Few people dispute that increasing the organic matter in farmlands soil creates more resilient, profitable agricultural systems and improves the health of ecosystems.

But there are many things a farmer needs to consider when deciding whether to implement a soil carbon sequestration project to sell carbon credits, such as:

- opportunity costs for farm businesses
- time and cost of measurement and reporting
- project maintenance
- permanence period obligations
- carbon price.

Future developments will affect how economically viable and practical these projects are in reducing global warming. New innovations may make farmers more confident to participate in carbon markets, but these are difficult to predict.

Uncertainty in achievable sequestration at farm or project scale in turn affects the potential for soil carbon offsets in Australia's long-term emissions reduction commitments and in corporate and industry net-zero targets.

We already understand the many benefits of organic carbon in soil. But to more confidently estimate how they impact emissions, we need more cost-effective, accurate measurement.

We also need evidence-based estimates of achievable long-term soil carbon sequestration for different management practices in Australia's diverse and variable climate and soil systems.

Nevertheless, while soil carbon sequestration seems unlikely to substantially offset emissions from industrial sectors, it does have potential to help agricultural industries become carbon neutral in line with market and consumer expectations.

Soil carbon offsets are measures of the amount of carbon from carbon dioxide locked away in the soil.

ATSE Events

In 2022, ATSE continues to host agenda-setting events that solidify and amplify our policy priorities and award-winning programs.

The science of climate change is unequivocal, and Australian communities are already experiencing its impacts on the environment, in industry and in everyday life. In September 2021, we launched our Net Zero Emissions Position Statement — calling for Australia to take urgent action to achieve net zero emissions by 2050 at the latest, and to set a more ambitious interim emissions target for 2030. We also urged the government to prioritise the immediate deployment of existing mature, low-carbon technologies that can make deep cuts to high-emitting sectors before 2030.

Our first Technology Towards Net Zero series webinar ***Fast Track to a Clean Future*** on 27 October 2021 discussed mature and emerging technologies that can help Australia transition to net zero emissions, in both energy supply and user demand sectors. In conversation with moderator Dr Katherine Woodthorpe AO FTSE, speakers Dr Helen Cleugh FTSE (Former Director of CSIRO's Climate Science Centre), Professor Andrew Blakers FTSE (ANU) and Scientia Professor Deo Prasad AO FTSE (UNSW) highlighted the clear climate science and key technologies already available that can be used in Australia to make deep cuts to our emissions this decade and set us on course to achieve net zero emissions as soon as possible.

As the global population and demand for animal protein grows exponentially, particularly for red meat and dairy products, technologists have been searching for more carbon neutral ways to support traditional industries or create new industries. In ***Feeding a carbon neutral world: Artificial meats and alternative proteins*** on 23 March 2022, Fellows and leading scientists Professor Paul Wood AO FTSE and Professor Michelle Colgrave discussed the future of ruminant protein and the cost-effective, resource-efficient and environmentally-friendly protein technologies and alternative solutions that are increasingly finding their way to the global marketplace. In another climate change webinar on 2 March 2022 facilitated by Professor Chien Ming Wang FTSE, Climate Foundation CEO Dr Brian von Herzen and Waterstudio.NL Founder Dr Koen Olthius spoke about some of the innovative solutions their organisations have developed, particularly how seaweed farming can regenerate a healthy climate and floating structures can mitigate floods and rising sea levels.

March 2022 was a particularly busy time of year for ATSE events. We were delighted to have Dr Cathy Foley AO PSM FTSE FAA, who was appointed as Australia's Chief Scientist in January 2021, as our ***Chaikin Orator***. Dr Foley, who has had a long and distinguished career at CSIRO, shared her experience as an internationally recognised physicist, influential leader and advocate in the STEM sector. While communities are still experiencing the fallout from the global pandemic, she emphasised the importance of science and the successful translation of research outcomes to plot a clear path ahead.

As part of our ATSE webinar series, on 3 March 2022, RMIT University's Madhu Bhaskaran and Sleeptite CEO Cameron van den Dungen shared RMIT's pioneering work which led to the creation of REMi®, a 'nearable' product with an array of sensors embedded into a medical-grade mattress cover designed to help aged care residents experience uninterrupted sleep. This revolutionary platform technology uses miniaturised and unbreakable sensors and has the potential to benefit the wider aged care, healthcare, sports and defence industries. Their presentation zeroed in on the challenges encountered in cross-sector collaboration, and what is needed to translate fundamental research into commercial reality.

On International Women's Day, our STELR, IMNIS and CS in Schools programs hosted a ***Changing Climates*** webinar to bring women in STEM directly into Australian secondary school classrooms to share their experiences and discuss how to build equality for a sustainable future. Students were given a live and interactive opportunity to hear from women working in research, the public and private sectors, and the pathways made possible by STEM.

In line with the advent of the digital era, the Industry and Innovation Forum presented our first Innovation Nation series webinar for the year on 17 February 2022, ***Advancing Australian Space Capabilities***. Hosted by Forum Chair Adjunct Professor Dimity Dornan AO FTSE and Appointed Member Professor Saeid Nahavandi FTSE, the event featured national and international experts from academic, research and industrial organisations to share state-of-the-art initiatives that advance and sustain space capabilities for the betterment of Australia.

In October 2022, we will be hosting our inaugural ***ACTIVATE*** symposium at the Sydney Masonic Centre — bringing together high-level representatives from across government, business and academia to discuss how Australia can meet the post-pandemic challenge of a burgeoning STEM skills shortage. We will also celebrate the outstanding achievements of our prestigious ATSE Award winners in an exclusive gala dinner on Wednesday 26 October.

To find out more and register: atse.org.au/activate2022

Fast track to a Clean Future

Energy Forum
Technology Towards Net Zero Series

Speakers
Dr Helen Cleugh FTSE
Professor Andrew Blakers FTSE
Scientia Professor Deo Prasad AO FTSE

Moderator
Dr Katherine Woodthorpe AO FTSE

These speakers highlighted the clear climate science and key technologies already available that can be used in Australia to make deep cuts to our emissions this decade and set us on course to achieve net zero emissions as soon as possible.

WATCH
atse.org.au/211027

Agriculture & Food Forum series webinar #2 Feeding a carbon neutral world — artificial meats and alternative proteins

Agriculture & Food Forum

Speakers
Dr Paul Wood AO FTSE
Professor Michelle Colgrave

This webinar hosted a discussion with leading scientists about the future of ruminant protein and the alternatives that are increasingly finding their way to the global marketplace.

WATCH
atse.org.au/220323

Advancing Australian Space Capabilities

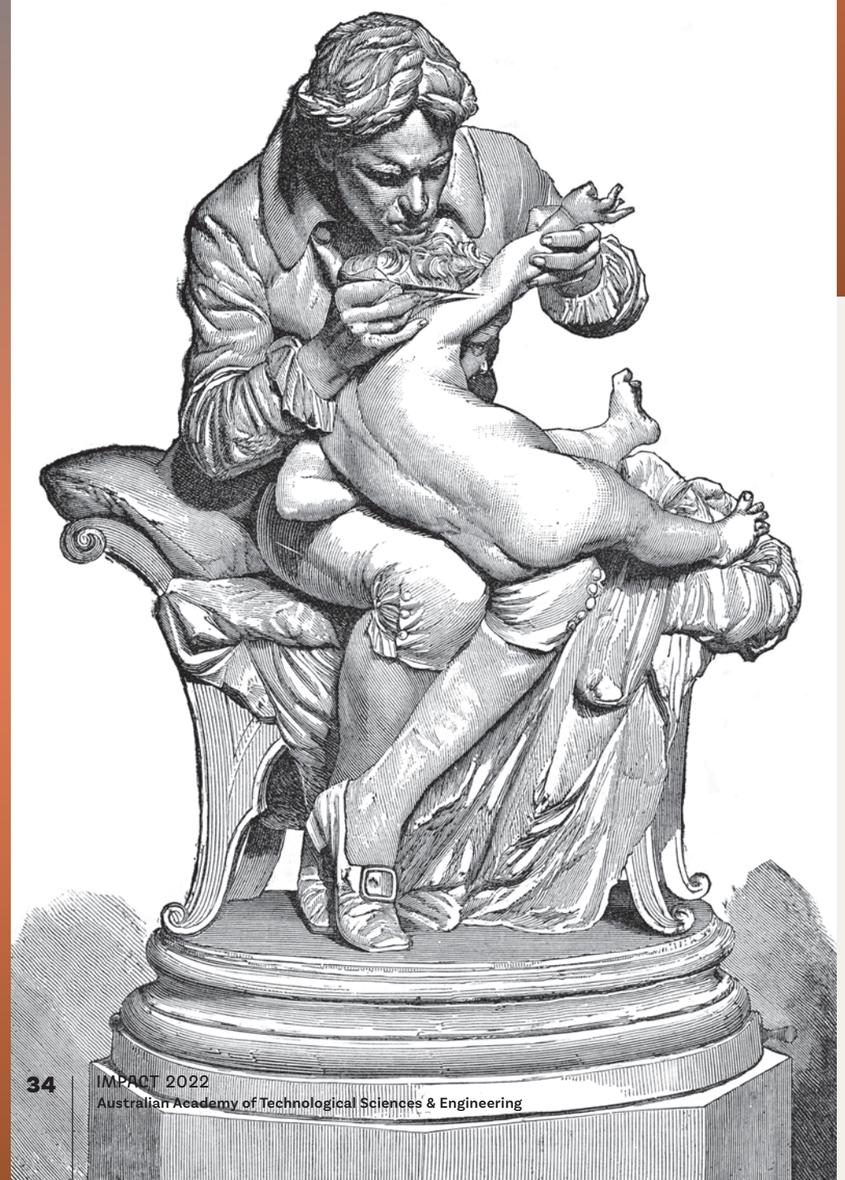
Industry and Innovation Forum
Innovation Nation Series

Speakers
Dr Edward Tunstel
Professor Andy Koronios
Dr Bhupinder Singh
Dr Anke Pagel

Moderators
Professor Saeid Nahavandi FTSE
Adjunct Professor Dimity Dornan AO FTSE

This webinar featured experts from academic, research and industrial organisations to share state-of-the-art initiatives that advance and sustain space capabilities for the betterment of Australia.

WATCH
atse.org.au/220217



Vintage etching of the statue 'Edward Jenner Vaccinating a Child Against Smallpox' by Giulio Monteverde (circa 19th century).

A TECH POWERED HUMAN DRIVEN FUTURE

Making human driven technologists

Why educating a generation of conscientious STEM professionals is the key to confronting our biggest challenges.

Professor Andrew Parfitt
FTSE

Andrew Parfitt is the Vice-Chancellor and President of the University of Technology Sydney. He has previously worked with the University of South Australia, the University of Newcastle, CSIRO and Defence Science and Technology. Andrew has a background in telecommunications and space science and led the Cooperative Research Centre for Satellite Systems. He works at the intersection of education, research, and industry.

In her essay *Of the Madness of Mad Scientists*, commemorating the 350th anniversary of the Royal Society, Margaret Atwood powerfully explores the ethical framework society expects of science.

She references the 'projectors' from Jonathan Swift's Gulliver's Travels (an order of nascent scientists who conduct strange experimental 'projects') to argue that we need to think about how technology should progress, not just how it can.

The assumed social licence for science and technology asks us to celebrate innovation and create solutions to critical problems. But it also forces us to consider the implications and consequences of those developments. There are many examples of this predicament.

UNIMAGINED HEIGHTS AND UNFORESEEN CONSEQUENCES

Atwood points to the automobile and highways of the 20th century: created as the machines and infrastructure of freedom; now polluting, clogged and far from the liberating agents they were originally designed to be.

The COVID-19 pandemic has again highlighted our capacity to transform the world with technology. Who would have envisaged that in just two years we would traverse the emergence and global spread of a new airborne virus to have fully vaccinated populations with enough immunity to return to almost-normal daily life?

But our self-satisfaction at the quality of our technological response must be moderated by the social, political, commercial, and logistical impediments to its equitable deployment.

Yet the global immunisation rate is less than 60 per cent, far below the rate we need to control the spread of the infection.

The inequity between rich and poor countries is stark.

The internet has facilitated enormous advances in how we share and access information, and opened opportunities for education, health, and other crucial services.

But social media has facilitated the dissemination of more myth and misinformation than any platform in human history — take anti-vaccination stances. That's not to mention growing concerns about how social media affects the mental health of children and young people.

Artificial intelligence and machine learning are admirable technologies that could reduce tedious work and automate routine tasks. But their threats to jobs, possible abuses in the wrong hands, and potential to intrude into privacy and erode social liberties, loom as concerns for regulators and adopters around the world.

Drones and robots used for environmental and resource management can also be used for surveillance and to deliver weapons.

The list goes on across so many areas of potential benefit to the community.

CONSCIENTIOUS INNOVATION

So, as technology creators, do we focus solely on the scientific advances, the new frontiers, making the impossible possible? Or as the custodians of innovation, should we also take a stand on the responsible use of technology?

This is a key dilemma for all of us: for institutions like the University of Technology Sydney, for those involved in the future of technology education — indeed also for the Academy.

My emphatic answer is that we must take a stand. And as a pragmatist, I believe the solution lies in how we educate people to envisage, develop, use, and respond to technology.

There will always be a place for appropriate regulation. But since education lies at the core of the challenges we face; it should also be central to our response.

BREADTH AND DEPTH

I've long believed that technological innovation lives in an ecosystem that transcends the laboratories and workshops where it begins.

When ideas leave the incubators and are implemented, users in the workforce and other decision-makers face wider considerations about how the technology will be deployed in the products and systems of the future.

Modern technology and engineering education attempts to embed business skills, ethical principles, global perspectives, creative and design practices, and many other dimensions within already crowded curricula.

At UTS, where I have the privilege to be Vice-Chancellor, we also pride ourselves on interdisciplinary and transdisciplinary learning, and ensuring our graduates understand Indigenous Australian perspectives for professional practice.

But with so many important priorities, how can we comprehensively and thoroughly educate technology professionals for the future?

The answer, I believe, lies not in any single degree. We need to turn to lifetime learning.

NEVER STOP LEARNING

Continuous development has long been a fundamental part of professional practice. But in our complex, interconnected world of economic, political, environmental, and technological disruption, it's the only way we can create the breadth of capability we need to be a technologically responsible professional community.

This idea is integral to ATSE's vision. The Academy engages, educates, and empowers STEM leaders at every turn in their career journeys. STELR and CS In Schools instil kids with a love of learning; IMNIS equips graduates to achieve their dreams in industry; and the Fellowship itself — a community of Australia's most experienced and innovators — shares knowledge and skills through events and other initiatives.

Employers and universities also increasingly see the importance of lifelong learning. They're creating new opportunities for upskilling and reskilling, and broadening offerings to meet the needs of both recent graduates and established professionals.

Informing the professionals of the future is not just about keeping their training up to date with the latest innovations.

We also need to increase technological literacy among those who have not needed it to date (just think about remote online working) and to broaden the capabilities of those who are already technologically literate.

Higher education is about more than just skills. As we strive to adapt to an ever-changing world, here are a few suggestions for a tech powered, human driven future.

HUMANISE STEM

First, we need to frame technology disciplines as human-centred professions, couched in the ideal of society's progression.

When I was growing up, the power and potential of electronics in and of itself inspired me to pursue a career in engineering. But now that digital technology has been adopted in all aspects of modern society, I'm not so sure that our digital natives are attracted to careers in technology for technology's sake.

The opportunity, then, is to curate learning journeys for students that provide intersections between the technologies themselves and the contexts in which they are used.

Doing this more overtly in our continuous learning offers enormous potential to engage and educate digital natives to help them evolve into cohorts of digitally informed professionals.

NURTURE DIVERSITY

Secondly, STEM education, and particularly the IT and engineering professions, have long suffered from a lack of diversity. This lack of diversity becomes even more pronounced at senior levels within organisations and within the innovation ecosystem.

Achieving greater gender diversity has been a particular focus, but in most technology-related areas we have a very long way to go. This widens the perceived gap between the power of technology and our human experience of it.

It has been well documented that diversity is a key element in organisational success. I proffer that the goal of humanising technology will only be achieved if we address this issue — not because equality will make technology more human-centric but because humanity itself is diverse.

BREAK DOWN BOUNDARIES

In the 21st century it is no longer adequate to view technology development and adoption as a purely scientific endeavour.

We often view other disciplines as complementing STEM. But it's a mistake to think of humanities, arts, and social science disciplines as the social conscience of technology, and the business or creative disciplines as the packaging. Today's students deserve and need more.

I've long believed that technological innovation lives in an ecosystem that transcends the laboratories and workshops where it begins.

To frame a lifetime learning journey with both breadth and depth, it's essential that we integrate these disciplines in a way that empowers professionals to understand and use technologies for positive outcomes and avoid the unintended and often unforeseen consequences of poor adoption.

TOMORROW'S LEADERS

Finally, in achieving a human driven approach to our technology powered future, we need this change to lifelong learning to be comprehensive and transformational right across the workforce.

More of the same — a just-in-time approach to skills needs in a market environment — simply won't get us to where we need to be.

The leaders of tomorrow must embed technology in their businesses and organisations from the inside. We will need their commitment to humanise that technology-enabled world.

A TECH POWERED HUMAN DRIVEN FUTURE

A holistic approach to research translation

Professor Emma Johnston
AO FAA FTSE

Professor Johnston is the Dean of Science and former Pro Vice-Chancellor (Research) at the University of New South Wales. She is a leading authority in marine ecology and has published over 100 peer-reviewed works.

When we think about translating research into beneficial outcomes, we often imagine a company bringing a new drug, app, or gadget to market. After all, this is the story in most marketing, as well as government policies and plans.

Take February's University Research Commercialisation Action Plan (The Plan), which focuses on opportunities to develop new products for export. The Plan points all its new funds (and some of the old) towards our national manufacturing priorities.

This investment represents less than one per cent of our current gross national spend on R&D, so obviously needs to be prioritised. But the small scale and narrow focus of policies like The Plan constrain the potential of Australia's research to benefit everyone.

We need to start seeing the goal of research translation as more than just making objects to sell. A successful outcome can be anything that changes the way we do things, such as new ways to improve mental health, restore ecosystems, fund education or measure human wellbeing.

We also need to expand our idea of translation to include all areas of research, not only the handful of STEM disciplines with the most straightforward applications. Commercialisation happens at the pointy end of a broad pipeline that starts with curiosity-led investigations and encompasses all areas of human exploration, from fine art to physics.

Developing new commodities is great. But lifting our creativity, ambition and investment in all aspects of research translation will lead to vastly greater commercial, social and environmental benefits for Australia and the world. So, how do we do it?

TINKERING AROUND THE EDGES

"Australia produces world-class research, but we fail to effectively commercialise our discoveries."

That refrain has been repeated (not without criticism) for the past 30 years. And during those three decades there have been countless reviews, inquiries, and incentives aimed at improving our Research and Development landscape.

But somehow, the old paradigm clings.

It's not as if we've been doing nothing. Think of the excellent work of CRCs, CRCPs, ITRCs, ITRPs, ARCLPs, MRFF (enough with the acronyms!). It's the depth and breadth of our ambition that's lacking.

Scale and capacity are big barriers. For example, our government agencies and businesses have fewer researchers than they did 10 years ago, and our economy is predominantly comprised of small and medium enterprises. These smaller businesses are certainly innovative, but they don't have the people or capital to focus on research translation at game-changing levels.

The Australian landscape is also unique in that most government support comes through indirect means, in this case the Research & Development Tax Incentive. This program supports industries to do their own research and development, but history has shown that most of this work is in development and not in research.

At best, this approach supports the application of existing knowledge in new ways. But it rarely facilitates the creation of truly new-to-market products or services.

STICK WITH THE PLAN?

So, will this latest initiative turn us around?

The good news is that The Plan is comprehensive, and was developed after thorough consultation. It aims to reduce cultural divides between business and universities, increase entrepreneurial opportunities, and target investment at the weakest points in our research translation pipeline.

A substantial new aspect of The Plan is 'Australia's Economic Accelerator' (AEA), a long-asked for injection of direct funding for research at the 'riskiest' stages of development. The AEA acknowledges the need for a fast-fail approach at the early stages and steps up support as a technology passes various hurdles.

The AEA is important because it begins to balance the Tax Incentives' indirect funding with direct government support. Even more importantly, this new investment will leverage — rather than leech from — other research programs.

But will this new initiative be the silver bullet needed to create substantial economic opportunities? Possibly not.

It will take time to implement and even more time to yield results.

It's also entirely focused on national manufacturing priorities. The Plan argues we need to concentrate our resources to be successful, which speaks more to the small scale of its investment than the wisdom of abstaining from a broader translation program across all areas where Australia is competitive.

The entire policy is only funded to the tune of $2.2 billion over 10 years (and that includes fellowships, PhDs, internships, a 'trailblazer program' and the AEA). That's about $220 million per year of additional government investment.

To give a sense of perspective, the Australian Higher Education sector alone spends more than $12 billion per year on Research and Development.

Australia's gross investment in R&D is $35 billion per year. So, The Plan adds less than one per cent to gross annual investment.

WIDENING OUR HORIZONS

For years now we've tinkered on the edges of our research and development landscape. Government and business investment has been declining for a decade, and we are well below the OECD average for gross investment in R&D as a proportion of GDP.

Considering the complex challenges we face with climate change, disease, and cyber security (to name just a few), an ambitious research translation strategy that takes advantage of all our clever ideas is a necessity.

The future of Australia will be enabled by new technologies but driven by people. The key to this future is substantial, long-term, direct government investment in a comprehensive research translation program.

To foster the future we want, we need a holistic approach to research translation — one that combines expertise from all disciplines, be they sciences or humanities. An approach based on an investment landscape that's diverse, flexible, and accessible, and an economy that's diverse, dynamic, and open to risks.

A strong research translation ecosystem also needs a long-term national strategy. In innovation powerhouses like Germany, businesses can rely on incentives well into the future.

For instance, the Fraunhofer institutes have been commercialising German research for the past 73 years. The project began as a single institute in 1950 and now spans 76 organisations across Germany. These institutes have created new products, from fat-free sausages to MP3 technology, and now CT scanning techniques to detect the tiniest cracks in concrete.

Germany also provides stable, long-term investment in blue-sky research. To successfully commercialise new ideas, we need to support exactly that — ideas.

SMASHING SILOS

So who will do Australian commercialisation and translation? As the Australian Chief Scientist, Dr Cathy Foley FTSE once said "Science cannot do it alone … what we need to do is pass the baton more efficiently."

Now in some cases that means equipping scientists and engineers with business and entrepreneurial skills. The enterprise-oriented PhD places and fellowships announced in the new commercialisation plan are a welcome start.

So too is the recognition that we need clear incentives and promotion pathways for all translational researchers. Researchers should be supported to progress their career while moving seamlessly in and out of industry.

We also need to recognise the role of people with humanities, arts, and science (HASS) educations to make a translation strategy a success. These are the people who can analyse market gaps, design products, developing training, understand psychology, assess risk, and tell the stories of success that can bring our innovations to the world.

And we don't just need HASS skills — we need HASS research.

Socio-ecological models that better predict the potential impacts of wildfires and floods will save both lives and livelihoods. Research that leads to a new way of educating disability support workers is as important as new disability enabling technologies. Research that helps us understand the nature of humanity is essential to ensure research into artificial intelligence is ethical and human driven.

If our focus stays glued to manufacturing things, we may fail to recognise the financial benefits of translating less immediately tangible research. We also need to seriously consider the growing risks of relying on developments that depend on finite research consumption physical export pathways.

The real innovation will happen when philosophers and engineers figure out how to work together.

A SPIRIT OF EXPERIMENTATION

The final ingredient for a successful research commercialisation strategy can't be addressed through research and skill alone. Rather, we need to also encourage business to be willing to fail and celebrate these failures.

Australian enterprise is notoriously risk averse. According to a report from CSIRO, only half of Australian companies have released a new product from 2017-2020. We're quick adopters of new ideas but are unwilling to be risk-taking creators.

Most of our companies are very small (97 per cent have fewer than 20 employees!). Some of our larger companies are either far too comfortable or conduct their R&D offshore.

Programs like the Australian Economic Accelerator can reduce risk for business by cutting research costs at the chanciest stages of translation and by connecting SMEs and start-ups with innovators studying research higher degrees.

Programs like this crucially recognise that not every new idea will translate effectively.

As researchers, we have always known this: we continually test new ideas and many of them don't turn out as hoped. We consider 'failure' is a sign of progress that allows us to move on.

Experiments, by definition, don't have certain outcomes — this is how human knowledge expands.

As a nation we need to be willing to consider translation attempts that don't work out as opportunities to learn, share those lessons, and move forward.

WHERE TO NOW?

We're at a point where the solutions to the challenges of the future must be developed now, if not 30 years ago.

We can't afford to pause and take the time to reconceptualise an entire R&D system. Thankfully we don't have to. We have all the information we need to build on the current system.

We have a thriving world class research ecosystem, reviews into the Research & Development Tax Incentive, reports on driving investment in innovation, horizon scanning reports on skills development, and numerous successful international examples to work with.

Australia's new research commercialisation plan is also a long awaited, step in the right direction.

We now need to expand on our programs with strong leadership, more ambitious investment, and a broad definition of research translation.

It's time to build a national research translation strategy for a viable, technology enabled, human driven future.

The future of Australia will be enabled by new technologies but driven by people.

CRC	Cooperative Research Centres
CRCP	Cooperative Research Centres Projects
ITRCs	Industrial Transformation Training Centres
ITRPs	Industrial Transformation Research Program
ARCLPs	Australian Research Council Linkage Projects
MRFF	Medical Research Future Fund

Fluid futures, STEM careers

Dr Sophie Calabretto
Dr Sophie Calabretto is an applied mathematician, fluid mechanist, and science writer. She currently works as the Lead Partnerships & Alumni Officer at the National Youth Science Forum.

Despite making up around 0.34 per cent of the world's population, Australia is responsible for 2.7 per cent of the world's scientific output[1]. As an applied mathematician, I can categorically tell you that punching above our weight by an order of magnitude makes Australia a bit of a powerhouse*.

(*In fact, that order of magnitude now puts Australia in competition with mitochondria for the title of true 'powerhouse' #celljoke.)

And yet, the number of students taking higher-level science and mathematics subjects in high school is in decline. It is now more important than ever that we continue to encourage the next generation to pursue their STEM passions, by making their future careers in these disciplines accessible, exciting, and achievable. If for no other reason than we'll need to ensure there's a steady stream of people to fix all the problems we may have accidentally created in our own lifetimes.

1. ARC Engagement and Impact Assessment 2018-19 National Report

And that's exactly what the **SHAPE YOUR FUTURE** – STEM career journeys with Australia's rising stars webinar series are all about. Through the STELR program, ATSE is connecting high school aged students with the best and brightest of the Australian STEM community.

Via a series of short presentations and interactive Q&A sessions with young, engaging researchers from both the tertiary education and industry sectors, this series encourages students to keep an open mind about the subjects they choose in high school, by showing them where those possibilities could take them. As naff as it sounds, the adage does ring true for a lot of people: if you can't see it, you can't be it.

I was fortunate enough to facilitate the *Let's circulate! Healthy ageing through vascular science* webinar, featuring Dr Rachel Climie and Professor Levon Khachigian; both AIPS Tall Poppies working in the field of vascular science, and all-round stellar individuals.

As someone with a vested interest in blood and circulation – blood is a non-Newtonian fluid, and the way that blood flows around arterial plaque leads to a bunch of very fluid phenomena – it was amazing to hear about two very different ways science can be used to improve the lives and health outcomes of others. I would've loved to have had the opportunity to participate in these kinds of events as the small, dork child I was.

Programs designed to inspire young Australians to value STEM, and its importance in our communities, are vital.

And although I say this from the very biased standpoint of someone working for an organisation that runs programs such as these, it is still true.

The National Youth Science Forum (NYSF) delivers immersive and transformative youth-led experiences to young Australians to encourage lifelong STEM literacy, and to show the wide variety of engaging, rewarding, and inspiring study and career options available in these fields.

As a student, I attended the NYSF's (flagship) Year 12 Program, which runs in January each year for students about to enter year 12, and to say this impacted my future study and career choices would be an understatement.

We need to continue to invest in these programs, encourage positive discussion about science in the community, and be part of the change that puts science, technology, engineering, and maths at the forefront of discussions about our future.

The Shape your Future Series will be continuing all this year, so you can tune in to hear from many more scientists. Full information is on the STELR and ATSE websites.

National Youth Science Forum

If you know any young people whose passions and interest in science, technology, engineering and maths are looking to be nurtured, applications for the 2023 National Youth Science Forum Year 12 Program opened in May.

www.nysf.edu.au

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STEM career journeys with Australia's brightest minds.

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atse.org.au/STELR

Celebrating innovation and excellence in STEM

Each year ATSE recognises outstanding senior and emerging innovators with national awards. The ATSE Awards are a flagship moment for ATSE and the Australian STEM community for celebrating our applied scientists, technologists, engineers and entrepreneurs from a diverse fields.

The 2021 Awards celebrated world-class research putting cancer cells to sleep, preventing catastrophic bushfires and improving the flavour of plant-based food options. The work of past winners from a range of fields, including fintech, biotech, engineering and agriculture has improved countless lives and built major new Australian businesses.

The ATSE Awards 2022 will continue a legacy of bringing together up to 600 of Australia's brightest minds across STEM who are collaborating for a better Australia and world.

The evening will feature a keynote presentation from an inspiring STEM individual and celebrate the 2022 ATSE Awards winners across the following categories:

- **Clunies Ross Award for Innovation**
- **Clunies Ross Award for Knowledge Commercialisation**
- **Clunies Ross Award for Entrepreneur of the Year**
- **Batterham Medal for Engineering Excellence**
- **ICM Agrifood Award**
- **Ezio Rizzardo Polymer Scholarship**
- **David & Valerie Solomon Award**

ATSE AWARDS 2022

GALA DINNER

ATSE Awards 2022
Doltone House
Jones Bay Wharf
Level 3 / 26-32 Pirrama Road
Pyrmont NSW 2009

Wednesday 26 October

Bernie Hobbs, award winning science writer and presenter and judge from ABC TV's *The New Inventors* will MC the three course dinner.

How to empower a young scientist

The experiment showing the blades on a horizontal and vertical axis

Early last year, the STELR team was contacted by the parent of a keen high school student from Sydney.

The student was looking to investigate how the axis of rotation of a wind turbine could influence the energy output. The team was pleased to be able to arrange a loan of some STELR wind turbine equipment to assist them in their investigation.

STELR sent her a set of the turbine blades along with the STELR wind generator and hub assembly.

She shared her results when it was completed. It showed some strikingly positive results when the turbine was placed on a horizontal axis, producing more energy in various wind speeds than the more traditional vertical axis.

The project book showed all the marks of a great scientist and investigator in the making.

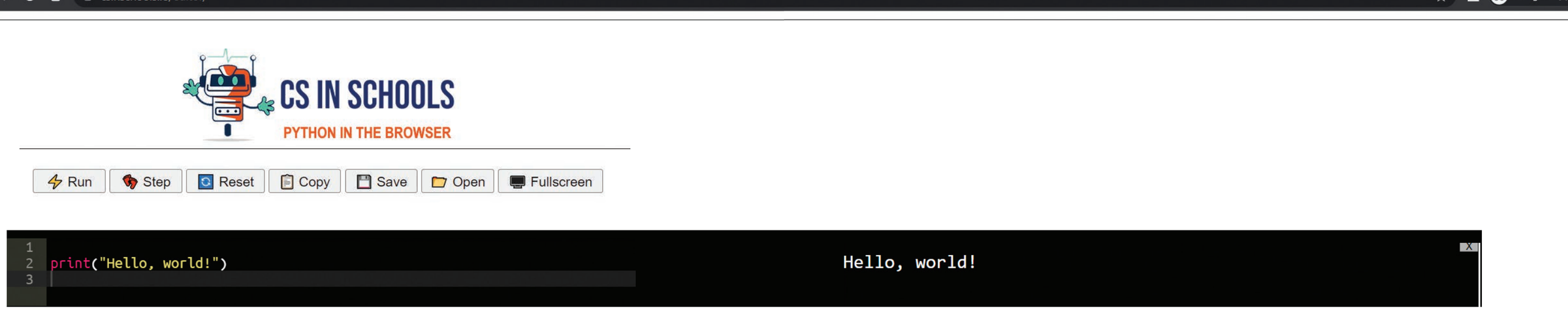
Her work gained her a third place for physics in the STA (Science Teachers Association) NSW Young Scientist Competition. She's has moved on to look at water quality sampling and measurement for her submission this year.

The STELR team is always looking for ways to assist students to pursue and gain knowledge in areas they are keen to explore.

stelr@atse.org.au

STELR turbine, clamping hub and blades from the STELR wind energy kit

STEM EDUCATION



Inspiring creative coding careers

Nancy Do

Nancy Do is a Senior Software Developer for Seek Jobs. She graduated from RMIT University with a degree in Computer Science after stumbling upon a coding subject at her previous science course. Nancy is passionate about encouraging and empowering girls and women into the tech industry through CS in Schools.

Nancy spoke at ATSE's International Women's Day STEM careers webinar on 8 March 2022.

When kids and young adults in ATSE's Computer Science in Schools Program ask me how I kicked off my coding career, they're often surprised by my answer.

When I was finishing my secondary schooling, I really had no idea what I wanted to do next. I was lost and didn't know what path to take.

Ironically, I now spend my days using my coding skills to find ideal candidates for jobs as a Senior Software Developer at Seek. I've been a professional in the tech industry for four years, with my work spanning Australia and Malaysia.

My all-girls high school didn't offer many computer skills. There were lessons in touch typing and using Microsoft Excel for basic data entry and simple calculations — that was pretty much it.

When I was due to start at university, I had a vague sense that I should do a science degree. The broad range of options science offered appealed to me.

I was right to follow my gut. Science let me explore different fields and gave me the freedom to find my passion.

I completed a Computer Science course and discovered that coding and programming are powerful tools.

Using lines of code, you can help smooth the journeys of thousands of commuters by programming traffic lights and creating better flows. Even the humble vending machine, that many a university student relies on, uses computing logic to turn currency to confectionery.

I had my light bulb moment: the possibilities and career opportunities with coding are endless. You can explore the sci-fi heights of artificial intelligence or dive into developing mobile apps to change everyday lives.

I also love how coding uses both the logical and creative sides of my brain. When we make software, we're literally transforming imagined possibilities into realities for people to experience.

But soon after moving over to a computer science degree, I realised that I was sometimes the only woman in the classroom. I felt further isolated in the knowledge that my male counterparts had been exposed to coding in secondary school.

I realised that the revelation I'd experienced at university about the potential of coding could have come earlier and wished that someone had sparked this interest for me at a younger age.

To keep momentum, I relied on great friendships and communities that gave me safe spaces to learn and grow my skills.

Following on from my degree, I joined a graduate program with Seek.

I thought I would feel more comfortable with a qualification, but not seeing many faces like mine made it hard to connect. Without representation, I felt the impact of imposter syndrome — I feared I didn't belong in the tech space.

When I investigated the lack of diversity in coding, I found that the tone of job advertising for computer science positions really attracted men.

I worked with Seek to reframe the ads to focus on the ability to work in a team, to communicate, and creatively solve problems. This successful change allowed and encouraged more women to enter tech jobs.

So, what do I tell those future tech legends I meet in the CS in Schools classroom? Here are my six top tips for someone who is interested in a career in computer science, coding, or programming:

- Be a sponge — use these opportunities to learn and grow as much as possible
- Only compare yourself to your past self
- Find your tribe — build multiple support systems with mentors, friends and communities
- Be curious in what you're passionate about
- Get comfortable with uncertainty — it is an opportunity to learn and grow
- Build a growth mindset by pushing the boundaries of your comfort zone (right now I'm learning bouldering to try to conquer my fear of heights!)

I've been volunteering with CS in Schools for three years because I love giving back to the community by empowering others and teaching them to code.

I want to show that the tech industry is fun and challenging and that there is a lot of room to be creative while solving problems.

I want to ensure that all students, including girls, have the opportunity to see what the world of computer science can offer them.

CS IN SCHOOLS

CS in Schools is an industry-supported coding teaching initiative creating sustainable change in Australian digital technology education. We help schools create relevant and meaningful computer science education by building industry connections with schools, providing a complete DigiTech pathway for all secondary students, and developing teacher confidence to teach digital technology.

From internships to inspiration

The IMNIS Initiative is growing and offering exciting opportunities for its alumni.

Navigating life as a PhD student or an early career researcher while trying to figure out your future can be confusing and strenuous. The journey to a steady and sustainable career in STEM isn't straightforward and can take a lot of unexpected turns.

Imagine facing those same challenges with an experienced guide by your side. Someone with real industry knowledge to help you find your direction, build your confidence, and point you to opportunities to hone and apply your skills.

The Industry Mentoring Network in STEM (IMNIS) is ATSE's flagship industry engagement initiative. We're proud to support and empower up-and-coming scientists, technologists, and engineers from diverse backgrounds across Australia. Now we're taking the initiative to the next level and changing the game for STEM careers in Australia.

LIFE-CHANGING MENTORING

IMNIS Engage

Since it began, our mentoring program (now known as IMNIS Engage) has connected 1300 PhD graduates and early career researchers from 18 leading universities around Australia with supportive industry leaders.

Engage prepares Australia's future innovators to excel in all aspects of their careers. Mentors help their Mentees better understand the STEM industry, identify the skills they need to succeed, discover new opportunities, expand their professional networks, and think about their fields in ways they may have never considered before.

As this award-winning program grows from strength to strength, we're further enriching the mentee experience with two exciting new programs: IMNIS Ignite and IMNIS Catalyst.

INSPIRING AMBASSADORS

IMNIS Catalyst

IMNIS Catalyst is a 12-month ambassadorship program that equips competitively selected Engage alumni with the tools and opportunities they need to share their inspiring journeys.

The program, which successfully completed its pilot last year, showcases the diversity of talent in the sector to catalyse curiosity, endeavour and a love of STEM across society.

Our Catalysts champion science, technology, engineering, and mathematics by:

- sharing their stories at secondary schools in collaboration with other ATSE programs such as STELR
- speaking at IMNIS events such as Visionary Leadership and Engaging with Industry
- providing peer mentoring to current IMNIS Engage Mentees.

ELECTRIFYING INTERNSHIPS

IMNIS Ignite

ATSE will soon launch IMNIS Ignite: a postgraduate internship program that gives Engage alumni paid, real-world industry experience and a direct bridge into professional STEM careers.

By connecting our brightest sparks with three or six-month projects at diverse host organisations, we're helping ignite the engine of Australian innovation.

We're also addressing the STEM workforce skills gap by giving businesses, government, and non-profits access to skilled, motivated researchers with deeper understanding of how to apply heir skills in an industry context.

IMNIS Alumni stories

Dr Edith Botchway
IMNIS Catalyst 2021

For me the most impactful thing I've learnt from this Catalyst program is the idea of thinking of myself as a leader irrespective of where I'm at, or which stage of my career I'm in. I mainly got that idea from Professor Joanna Batstone's keynote presentation during our Visionary Leadership program.

Specificially, what she shared about being a leader in her research sphere, combining family and work and everything else that comes along with it. I found that particular idea very empowering. Going forward, it's helping me and will help me to make an impact wherever I find myself.

Thilanka Morawakage
IMNIS Catalyst 2021

The IMNIS Catalyst program has made a difference to me by providing me with opportunities to raise my profile, build my science communication skills to confidently communicate and influence others and has allowed me to connect with like-minded people.

The skills and knowledge I've gained, and interactions I have had through this program will help maximise my opportunities to gain experiences in science communication and advice from experts in the years to come.

Catriona Nguyen-Robertson
IMNIS Catalyst 2021

What's incredible about the IMNIS Catalyst program is that it's still taking shape. The things that are outlined that you might get the chance to do, might not be an extensive list, but you get new opportunities thrown at you because you are an IMNIS Catalyst.

It can provide you with more opportunities than you can think of and even take you in directions you may not have considered going in.

Dr Jana Phan
IMNIS Mentee 2016/2017

People tell you that there are multiple, diverse career paths outside of academia, but I don't think I really understood how this would be possible for me until I could grasp how my skills were valuable and could be transferred into other careers. IMNIS gave me exposure to the 'outside world'.

Dr Anjaleena Anthony
IMNIS Mentee 2017/2018

You become aware of the latest opportunities, market shifts as well as just knowing where others are on their career journey and having the ability to share your own journey.

GET INVOLVED

IMNIS Ignite and **IMNIS Catalyst** harness the sense of momentum and connection that comes from completing an **IMNIS Engage** mentorship.

These programs highlight the exciting world of diverse career choices that await our alumni.

If you or someone you know would like to learn more about the IMNIS Initiative and these new opportunities, please contact us:

IMNIS@atse.org.au

A TECH POWERED, HUMAN DRIVEN FUTURE

How AI is powering us

Innovative new Artificial Intelligence technologies have extraordinary potential to improve our lives — and Australian researchers are leading the charge.

Artificial Intelligence (AI) refers to the collection of technologies and techniques used to solve problems that would otherwise require human input.

Human uses for AI have grown across every aspect of our society, from identifying bruising on fruit to coordinating batteries to store energy more efficiently. The potential of AI to transform society is massive, and its impact is only projected to increase.

Because AI is not always easy to see, it can be difficult to imagine how it is already having such a revolutionary impact.

The dramatic and rapid emergence of AI as one of the key drivers of the modern global economy is difficult to overstate. Before 2030, $13 trillion worth of global activity will be underpinned by AI technologies.

Projections point to a potential windfall for Australia of around $300 billion. But this growth and economic opportunity will only be realised if our AI sector is sufficiently supported, coordinated and industry-focused.

Building on an impressive research foundation, Australia has the capability to become a genuine leader in the global AI space and deliver profound economic and social benefit.

This series is a snapshot of the innovative work in AI research happening across Australia.

The examples were selected by an expert ATSE project team to assist businesses or organisations understand how Australia's AI expertise can be leveraged in real world applications to deliver economic and social outcomes.

AUTHORS

Professor Mike Miller AO FTSE*
Telecommunications researcher

Dr Oliver Mayo FAA FTSE
Evolutionary geneticist

Distinguished Prof Mary-Anne Williams FTSE
Data scientist

Professor Shazia Sadiq FTSE
Computer scientist

Professor Anton van den Hengel FTSE
Australian Institute for Machine Learning

Professor Svetha Venkatesh FTSE
Computer scientist

Professor Glenn Wightwick FTSE
Systems engineer

Distinguished Professor Fang Chen
Data scientist

Dr Jackie Craig FTSE
Defence researcher

Dr Paul Dalby
Australian Institute for Machine Learning

EDITING Edwyn Shiell

*Mike Miller AO FTSE sadly passed away on 30 November 2021. You can read Professor Miller's obituary on page 63.

AI nation

Snapshots of Australian innovation

Queensland

The future of self-driving cars

The Queensland University of Technology (QUT) Centre for Robotics took an electric car fitted with high-tech sensors on a 1200km, three month-long road trip to test drive the future of autonomous driving in Australia.

The car used robotic vision and machine learning to see and interpret everyday road signs and markings essential for safe road use. Taking the car on the open road highlighted several considerations for Australia's driving infrastructure that we need to consider before autonomous driving can become widespread:

- Ensuring camera-vision systems can correctly identify and interpret signs, traffic lights and lines on the roads are a priority
- Improving technology to deal with inclement weather and driving at night
- Improving roadside infrastructure to clear obstructions.

Western Australia

RailSmart Wanneroo Planning Support System

Australian cities are growing and rapidly expanding at their edges. This is challenging for city planners to model and plan infrastructure to ensure people have access to essential amenities and a strong sense of place.

The Systems for Knowledge Discovery from Data research cluster at the University of Western Australia brings together experts in data mining, cybersecurity and sensor network systems.

They contributed to the Planning and Transport Research Centre's partnership with the City of Wanneroo to create a predictive urban development tool that is visual, interactive, and easy to use.

The tool can be used to plan public transport growth and create jobs.

South Australia

Better grapes, better wine

The University of Adelaide is working with Riverland Wine and Wine Australia to develop tools for Australian wine grape growers that monitor, predict and advise on managing aspects of viticulture such as irrigation, pruning and application of pesticides.

The digital platform, called VitiVisor, collects information with new sensors that use computer vision to measure vineyard growth.

Collecting so much data for analysis allows growers to track performance and make more informed management decisions for more efficient yields. The project will assist growers to produce better grapes and empower them to better manage contracts with wine makers.

Victoria

Supporting fast and accurate trauma care

Over 1000 patients go to the Alfred Trauma Service each year with major injuries that can cause death or disability. For these patients, the care they receive in the first 30 minutes is critical to their survival. For the staff, the first 30 minutes' procedures and process are carried out under extreme pressure.

The Applied Artificial Intelligence Institute (A^2I^2) at Deakin University collaborated with Alfred Health to create the Trauma Reception and Resuscitation System (TR&R). It monitors patient data, such as vital signs and diagnosis information, and provides advice and treatment options based on hospital procedures and guidelines.

A large screen visible to all staff displays these recommendations in real time to support decision-making. The TR&R system has slashed missed steps by 21 per cent, reduced the need for blood transfusions by 30 per cent, and cut the time required for treatment in the Intensive Care Unit by a life-saving 26 hours.

New South Wales

Stop the leaks!

Australia has more than 140,000 kilometres of water pipes. A major pipe failure can disrupt everyone's lives — from utility workers to consumers.

Collaborating with more than 30 utilities in Australia and internationally, AI researchers working with the University of Technology Sydney (UTS) Data Science Institute examined one million pipe failure records for 10 million pipes over the past decade.

Sydney Water provided access to 20 years of digital data from their five million customers so UTS could develop the world's-first pipe failure prediction tool.

As a result, Sydney Water can now complete intelligent condition assessments, repairs and renewals to improve the performance of water assets. Eighty per cent of failures predicted so far by the UTS team were within 200m of where the fault actually occurred, dramatically narrowing areas to direct maintenance efforts.

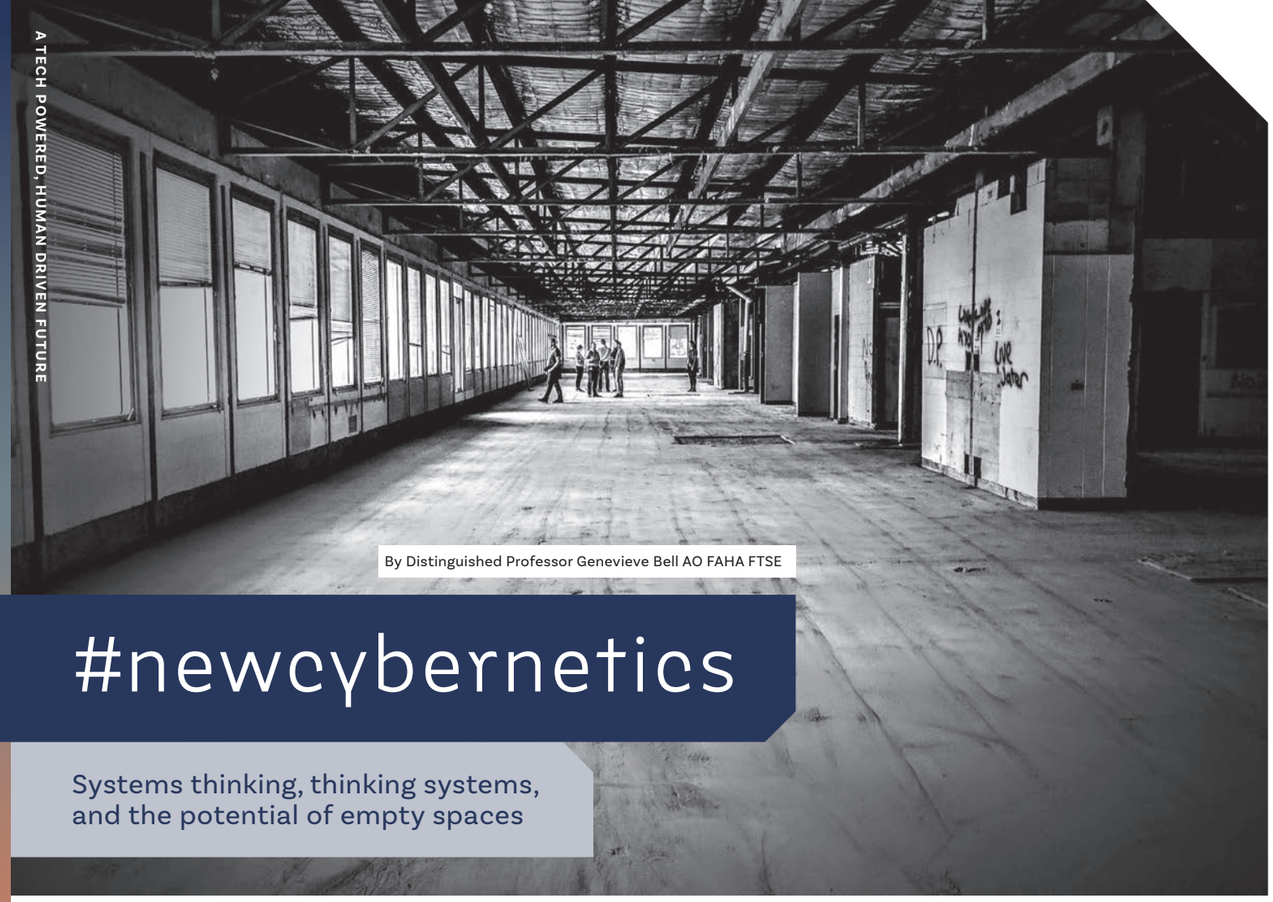
Australian Capital Territory / Tasmania

The CONSORT Bruny Island Battery Trial

The Australian National University (ANU) led the CONSORT Bruny Island Battery Trial in collaboration with Reposit Power (an energy software small and medium enterprise), and TasNetworks (a distribution network service provider).

The trial uses innovative Network Aware Coordination (NAC) software to coordinate consumer-owned distributed rooftop solar and batteries with network demands.

The AI software was able to plan ahead to automatically provide coordinated battery discharges, at the exact times when the undersea cable supplying power to Bruny Island was in danger of overloading. For the first time, TasNetworks avoided using their backup diesel generator during a major network peak.



By Distinguished Professor Genevieve Bell AO FAHA FTSE

#newcybernetics

Systems thinking, thinking systems, and the potential of empty spaces

Birch Building, The Australian National University
April 2019

Distinguished Professor Genevieve Bell
AO FAHA FTSE

Genevieve Bell is a renowned anthropologist, technologist, and futurist. Genevieve completed her PhD in cultural anthropology at Stanford University in 1998 and is best known for her work at the intersection of cultural practice and technology development. She is currently the Director of the School of Cybernetics at the Australian National University and a Vice President and Senior Fellow at Intel.

It was big. Really big. That's what I thought to myself.

If you're old enough, you can't think those words without hearing Douglas Adams intoning that 'space is big, really big. You just won't believe how vastly hugely mind-bogglingly big it is. I mean, you may think it's a long way down the road to the chemist, but that's just peanuts to space.'

In this case, it was a building that boggled my mind. In April 2019, I found myself on the third floor of Birch — the old chemistry building at The Australian National University (ANU). It was nearly 3500 square metres of space in a neglected mid-century pebblecrete gem with zany heritage portal windows and a travertine floating staircase.

There was dust and debris and broken venetian blinds. The ceiling had been torn out leaving behind exposed metal struts and silver insulation. Holes in the concrete floor and walls were covered with makeshift timber partitions and spray-painted signs screamed 'CAUTION' in dripping black letters.

And yet despite all that, it was beautiful — full of light, and space and possibility. Full of prospect, for this new space was to be our new home. Of course, before that could happen, we had to decide on the renovations, and where to put the walls, and bathrooms, and kitchens and offices.

We had to work out how to fill this space — this big, really big space.

A NEW BRANCH OF ENGINEERING

It seemed ambitious, but ambition has characterised much of what we had done together in the years leading up to that moment.

We had gotten started back in September 2017, when we created the Autonomy, Agency, and Assurance Innovation Institute (3Ai) to establish a new branch of engineering to take artificial intelligence safely, responsibly, and sustainably to scale.

We started with artificial intelligence because we believed it was not a technology per se. It was, in fact, part of a system, and we knew that system needed a different kind of conversation. So, we set about to create that conversation: one with a multitude of moving parts and potentially global implications. Ambitious certainly, possible crazy, but important.

By necessity, we were aggressively iterative and interdisciplinary. We built on existing core strengths in computer science and engineering, as well a novel blend of design ethnography, critical studies of science and technology, philosophy, and business strategy.

We brought together researchers and practitioners from across the higher education sector, as well as the public sector and private industry. Within the first year, we had a staff of ten. By the time we were standing in Birch, we also had our first cohort of Masters students, and we were experimenting with short courses.

We had early partnerships with Macquarie, Microsoft, KPMG and CSIRO's Data61. And we were growing — we had plans for more students, more courses, more staff, more collaborations. Enough perhaps to fill that space, if we pushed hard.

We had no idea, standing there, our voices echoing the length of the building, that our plans would be impacted by a global pandemic, a country-wide COVID-19 lockdown, an economic shock to the higher education sector, and a complete restructuring of the College of Engineering and Computer Science.

By the time we moved into the Birch building in July 2021, with its now white walls, and timber panelling and huge light spaces, classrooms and corridors, our world was very different than the one we had imagined.

WHAT IS CYBERNETICS?

In January of 2021, we had taken a leap of faith and paperwork, and 3Ai became the heart of the School of Cybernetics — the first new school at the ANU in decades.

Now for some of you, I suspect, cybernetics is but a faintly familiar thing; this thing you think you know but can't quite place. It is a familiar stranger, or an echo of an earlier conversation, or at the moment, the field of Professorship of the father of the President of Ukraine.

But really, for me, it starts, in the aftermath of World War II. Thinkers around the world discussed what to do with all that computing power and data; and about what this would mean for how the world could — and should — be. Cybernetics offered one way through.

Cybernetics, as articulated in 1940s America, was a framework for managing the introduction of computers into existing machinery and practices.

It was a systems view that privileged the relationship between the pieces and the whole; that required an understanding of feedback and feedback loops; and that insisted that the system was always and already composed of human, technical and ecological components.

For me, one of the abiding lessons from the last two years has been about the importance of such systems — complex dynamic systems that bring together technology, culture, and ecology.

Indeed, when what was sometimes most clear was the fragility of local and global systems, it was hard to resist the appeal of cybernetics as a way to make sense of these systems and re/build them anew (see 2021 Garran Oration).

A WORLD OF SYSTEMS

I have an affinity for systems; my friends joke about it all the time. I see them everywhere I go.

As a child I grew up surrounded with stories of systems — the human systems that unfolded as my mother studied anthropology at Monash University in the 1970s.

Those systems of kinship and social organisation were circles and triangles and lines on blackboards. Those systems organised, in the most abstract sense, marriage and inheritance as building blocks for human societies.

As a five-year-old I knew none of those things. I just knew that the triangles and circles and lines made patterns. And I knew those patterns — or at least I recognise the outline of their magic. I suspect this was no comfort to the adults who shared my mother's learning experience when the five-year-old could intuit what made matrilateral cross-cousin marriage work and they could not!

I also grew up with stories of technical systems. My father did, on one memorable occasion, let me help him dismantle and reassemble a diesel-powered vintage engine. It was all metal pieces. Some blackened with age and grease, others with chipped red and green enamel paints, and bolts that held it all together.

The sound it made as everything moved: that was the pattern, the magic.

Standing here in 2022, it is easy for me to see a world of systems and their interdependencies, fragilities, and breakpoints. In pondering the world that we are building and the world that we must inevitably inhabit, seeing systems is both a blessing and sometimes a curse.

The curse is that not everyone sees the systems, and not everyone wants them to change. The blessing is that it helps, for me at least, prompt action — systems are things we can build, things we can shape, things we can change, and systems are something for which we can prepare others, and for which we can train others to engage with — critically, carefully, and thoughtfully.

It takes many voices. As I always tell anyone who will listen, the seduction of the hero's journey story — the Joseph Campbell archetype of a lone inventor battling a cruel and complicated world only to emerge victorious — is immensely powerful in the annals of technological innovation.

Stairwell Birch Building February 2022

IT'S ALSO JUST WRONG.

With surprisingly few exceptions, our key inventions, especially those in the digital realm, were not solo gigs. They arose out of the complex interplay of ideas, personalities, corporate cultures, university politics and late-night conversations and disagreements.

(Walter Isaacs' book The Innovators does a splendid job of unpacking and unpicking the lone inventor mythos in Silicon Valley; it is worth a read just for that thread alone.)

The School of Cybernetics has been no exception. Our priority is growing a community of remarkable humans who share a belief that we can and should actively build a better future. Our journey has been a collective, collaborative and occasionally conflict-filled one — and we've made amazing things because of that productive discomfort.

We have a cohort-based Masters (2019-), a cohort-PhD program (2020-) and a suite of micro-learning activities (2019-). To date, we have had four vibrant and robust cohorts of students with a diversity of academic and cultural backgrounds, professional experiences, age range, life stages, gender, and sexuality.

Our track record of having 50 per cent female students is striking in engineering and computer science. We lay claim to graduating the first Indigenous Masters students in the history of the College — the first to be sure, and we sincerely hope not the last.

Our micro-learning activities have seen us engaged with industry and government leaders, as well as local community organisations, and we have continued to partner with Microsoft, KPMG, and others to help provide access to our experimental curriculum and pedagogy.

We knew we could, and should, equip people with the capacity to see the full dimensions of systems and have the tools with which to engage in designing, building, regulating, securing, resisting and even decommissioning systems.

That said, there is probably a rulebook somewhere that says you should not start a new School in the middle of a pandemic. We did it anyway, together.

And, as we keep telling our students, it's never about the technology per se, it's about the people, the stories we tell, and the places we tell them. It is about the worlds we want to make in the future, and the things we need to do today to make that possible.

As humanity faces down monumental systemic challenges, it's worth remembering that it's never the wrong time to invest in building new ideas and new kinds of thinkers and doers. And finding ways to occupy big — really big — spaces!

MORE

Podcast
Interested in how systems inform innovation, from the kitchen to stars? Listen to our podcast of Genevieve Bell's ATSE keynote address:
atse.org.au/190613

A TECH POWERED, HUMAN DRIVEN FUTURE

Virulizer

Transformative ten-minute tests

Professor Dayong Jin FTSE is an acclaimed scientist who has dedicated himself to using light waves and particles to achieve single molecule sensitivity. He develops biomedical, analytical, and imaging devices that will detect diseases much earlier, including cancer.

Professor Jin was elected as an ATSE Fellow in 2021 and continues to undertake inspiring work.

Professor Jin was elected as an ATSE Fellow in 2021 and continues to undertake inspiring work.

His recent research has had a large focus on single molecule detections. This technology has a range of potential uses, but Professor Jin and his team shifted their focus towards COVID-19 research when the pandemic began reshaping the world.

The team adapted novel 'Super Dot' technology to develop an innovative new COVID-19 test — Virulizer.

Virulizer uses saliva instead of a nasal swab. This method is much more comfortable, can detect the virus more quickly than a traditional PCR test and is a thousand times more accurate than a rapid antigen test.

With the power to deliver results matching the reliability of a PCR test in 10 minutes or less, Virulizer has the ability to change how the world navigates COVID-19.

"This is going to be a game-changer — I strongly believe that," Professor Jin said.

Due to its level of sensitivity, Virulizer is extremely effective at detecting COVID-19 in asymptomatic individuals. As saliva contains lower virus quantities than the nose, the high sensitivity offered by Virulizer allows the low abundant virus antigen molecules to be detected during the early stages of developing a COVID-19 infection.

"With the sensitivity of our optical technology, we aim to identify the viral protein in saliva from asymptomatic but already infectious patients. This would allow for much more effective contact tracing and rapid discovery of pockets of disease before it is transmitted to others," Professor Jin says.

The development of Virulizer is the result of a collaboration between Professor Jin's team at the University of Technology Sydney and Western Australian manufacturer Alcolizer.

Professor Jin recalls the excitement felt at midnight on Friday 1 August 2020, when the team received the first results from the pilot project.

"We got excited then that the technology had the potential to be useful. When we showed this result to Alcolizer, they got excited too and they began to get more involved."

Production rollout is scheduled for mid-2022, with the second clinical trial currently underway in WA. Tests can be made available to early use customers if emergency use authorisation is given.

Professor Jin and his team are now working on developing super-resolution imaging techniques to monitor the pathogenic functions of emerging variants. They are also investigating immune responses to viral infection to better understand the likelihood of Long COVID.

Australian of the Year nominations

Professor Veena Sahajwalla
FTSE FAA

Professor Bronwyn Fox
FTSE

Named 2022 NSW Australian of the Year

Best known for inventing the process to create 'green steel' and launching waste-transforming 'microfactories', Professor Sahajwalla is the founding director of UNSW's Centre for Sustainable Materials Research and Technology.

'Promoting STEM (science, technology, engineering and maths) and greater sustainability continue to be extremely important to me,' Professor Sahajwalla said.

'And as I engage with many people every day, I see these issues are generating a community and industry groundswell that we should embrace to help our society collectively tackle the challenges we face, to improve our environmental, social and economic wellbeing.'

A Fellow of the Australian Academy of Technological Sciences and Engineering since 2007, Professor Sahajwalla was on the Expert Working Group for our major report *Towards a Waste Free Future: Technology Readiness in the Waste and Resource Recovery Sector*.

It calls for a transition to a circular economy to reduce and recycle the 67 million tonnes of waste Australia produces each year.

Nominated for 2022 Victorian Australian of the Year

Another ATSE Fellow, Professor Bronwyn Fox FTSE, was a nominee for 2022 Victorian State Australia of the Year.

The CSIRO Chief Scientist and Swinburne University researcher has pioneered groundbreaking techniques to 3D-print carbon-fibre composites.

These strong, light-weight materials are used to manufacture everything from passenger gets to sporting equipment.

Professor Fox is the Chair of the Academy's Victoria Division.

Australia Day Honours

Congratulations to our Fellows recognised in the Australian Day Honours list for their amazing contributions to science, technology, and engineering. Eight Fellows of the Australian Academy of Technology and Engineering have been named in the 2022 Australia Day honours.

The Fellows were among 1040 outstanding Australians to be awarded for their achievements and contributions to the nation. Only seven Australians were recognised with the Companion of the Order of Australia, and three of those are Fellows of our Academy. Of the 732 awards in the General Division of the Order of Australia, the highest ever percentage (47 per cent) are for women.

Academy President, Professor Hugh Bradlow, said, "These awards indicate the range of significant contributions and demonstrated excellence in STEM fields by ATSE Fellows.

"I would especially like to congratulate former ATSE President Dr Alan Finkel on his inclusion in the COVID-19 Honour Roll as recognition of his valuable work during the pandemic.

"I know every member of the Fellowship will join me in congratulating the eight Fellows honoured."

COMPANION OF THE ORDER OF AUSTRALIA (AC)

Distinguished Professor James Dale AC FTSE

Elected to ATSE in 2014
For eminent service to agricultural science, particularly through biological and biotechnological research and development, leadership, and to gene technology.

Dr Alan Finkel AC FAA FTSE FAHMS

Elected to ATSE in 2006, President 2013-2015, Clunies Ross Award 2005
For eminent service to science, to national energy innovation and research infrastructure capability, to climate change and COVID-19 response initiatives, and to science and engineering education.

Dr Graeme Moad AC FAA FTSE

Elected to ATSE 2021, Clunies Ross Award 2014
For eminent service to science, particularly polymer design and synthesis and radical polymerisation, education through mentoring, and to professional scientific organisations.

OFFICER OF THE ORDER OF AUSTRALIA (AO)

Dr Susan Barrell AO FTSE

Elected to ATSE 2013
For distinguished service to earth science through meteorology and research organisations.

Professor John Church AO FTSE

Elected to ATSE 2004
For distinguished service to climate science through oceanographic and sea-level research and publications.

Dr John Gladstones AO FTSE

Elected to ATSE 1976
For distinguished service to primary industry, particularly agriculture and viticulture, and as an author.

MEMBER OF THE ORDER OF AUSTRALIA (AM)

Professor Hua Kun Liu AM FTSE

Elected to ATSE 2013
For significant service to the scientific research sector, and to tertiary education.

Professor Xinhua Wu AM FTSE

For significant service to manufacturing science, to tertiary education, and to engineering.

Movers & shakers


1. Genevieve Bell


2. Liz Dennis


3. Min Gu


4. Karen Hapgood


5. Neena Mitter


6. Else Shepherd


7. Kadambot Siddique


8. Sam Walsh


9. Tony Weiss


10. Saeid Nahavandi

1. Genevieve Bell
Professor Genevieve Bell AO FAHA FTSE has been named one of the top 10 women in technology in Asia-Pacific by Business Chief for her work as a cultural anthropologist, pioneering technologist and futurist, in particular her work at the intersection of cultural practice and technology development.

2. Liz Dennis
The Australian Academy of Science awarded molecular biologist Dr Liz Dennis AC FAA FTSE the 2022 Ruby Payne-Scott Medal and Lecture for her ground-breaking work increasing yields in hybrid crop varieties.

3. Min Gu
Optica, the global society for optics and photonics, has awarded physicist Professor Min Gu FAA FTSE the 2022 Emmett N. Leith Medal.

4. Karen Hapgood
Swinburne University of Technology has appointed engineer Professor Karen Hapgood FTSE Deputy Vice Chancellor for Research.

5. Neena Mitter
The National Academy of Agricultural Sciences, India, has elected horticultural scientist Professor Neena Mitter FTSE as a Fellow.

6. Else Shepherd
Adjunct Professor Else Shepherd AM FTSE, CEO in Residence at the Queensland University of Technology, has recently had one of the Cross River Rail boring machines named in her honour.

7. Kadambot Siddique
The Pakistan Academy of Science has elected agricultural scientist Professor Kadambot SiddiqueAM FTSE as a Foreign Fellow.

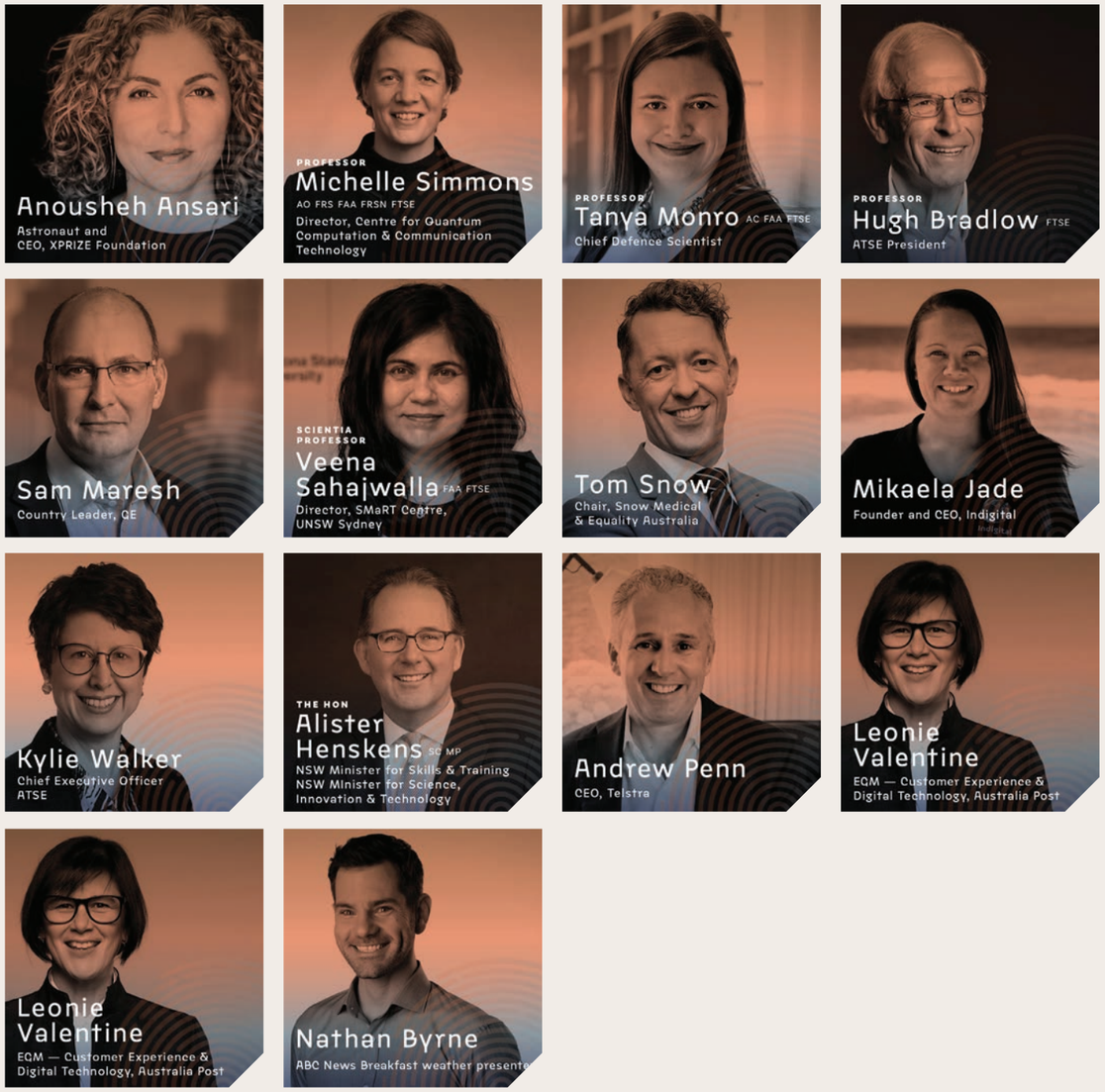
8. Sam Walsh
Dr Sam Walsh AO FTSE has been awarded Japan's prestigious Order of the Rising Sun, Gold Rays with Neck Ribbon for his "outstanding contributions to the promotion of economic relations between Japan and Australia".

9. Tony Weiss
The Royal Australian Chemical Institute has awarded Professor Anthony Weiss AM FTSE the Weickhardt Medal. The National Academy of Inventors, USA, has also made him a Fellow.

10. Saeid Nahavandi
Professor Saeid Nahavandi FTSE was named Professional Engineer of the Year by Engineers Australia in recognition of his work on world-first haptically-enabled robotic and virtual-reality systems for real-world application.

ACTIVATE 2022

Confirmed speakers (as of June 2022)



VALE

Professor Michael Joseph Miller AO FTSE

Professor Mike Miller AO FTSE was co-chair of the Academy's Digital Futures Working Group, part of the membership committee, and a co-founder of IMNIS. Former ATSE President Alan Finkel AC FAA FTSE was proud to call Mike a mentor, and has contributed the following tribute.

My mentor, Mike Miller, and I did not see each other for the last few years, simply for the hopeless reason that we were travelling on different courses. Mike's passing was a terrible shock, accompanied by overwhelmingly personal sadness and deep sorrow for you, Edith, his loving wife, and all of his family.

I first recall Mike's and my paths crossing shortly after I had been elected as a Fellow of ATSE, the Academy of Technology and Engineering. I had been asked to put together a proposal for a new co-curricular science education resource called STELR, for secondary school students. Having run my own small company all my working life, I knew nothing about large organisations and even less about Learned Academies, but Mike knew it all and took it upon himself to gently introduce me to the nuances of Learned Academies. Even further beyond my ken, Mike knew how governments operate and managed to persuade the federal minister of education to visit one of our STELR schools and express his support.

I joined ATSE with fresh ideas; Mike nurtured them and helped turn them into deliverables. For that, I owe him much gratitude.

Later, when I was President of ATSE, Mike was the Vice President who helped me understand the disparate needs of Fellows and Divisions. Without Mike, my time as President would have been less productive, less satisfying. Mike led with aplomb the single most awkward issue for a Learned Academy — the guidelines and processes for selecting new Fellows and managing the expectations of disappointed Fellows whose nominee did not get elected.

Mike was never one to sit on his hands waiting for other people to generate the good ideas. For example, he established a program of Parliamentary Briefings by ATSE Fellows in South Australia, to update politicians on technology matters that they themselves identified as being of most interest to them. This became the model for similar program in other state Divisions.

Somewhere during those years, on a visit to Adelaide hosted by Mike in his capacity as Chair of the South Australian Division of ATSE, I was fortunate to meet delightful Edith, and I was honoured to enjoy a friendly overnight stay at the Miller family home.

Later, when I was Australia's Chief Scientist and leading a review of the national electricity market after the whole of state blackout in South Australia, Mike garnered advice on the history and limitations of the operation of the electricity market, all of which was eagerly absorbed by me. And he continued to engage with me and help on the educational activities that I led from my new role.

Mike had boundless skills, so ably recorded for posterity by the conferring on him of the 2017 Pearcy Medal, the highest award to honour a lifetime of achievement in Information and Communication Technology in Australia.

When Mike retired as Vice President, I wrote to him, "Gosh, I am going to miss you in the role."

And today I say the same, gosh, Mike, I am going to miss you.

To Edith, family and friends, take heart in your joyous memories of a wonderful man.

With thanks to Alan Simon Finkel AC FAA FTSE

Professor Eric Franklin Wood FTSE

Professor Wood was known for his enormous impact in the field of hydrology. He contributed pioneering work to the development of hydrologic modelling, the use of satellite remote sensing data, and the creation of continental and global climate models for parts of the world that had been historically overlooked.

Born in Vancouver, Canada, Eric received a Bachelor of Science in civil engineering from the University of British Columbia before moving to the United States where he earned his doctorate from MIT in 1974. He worked for two years in Austria at the International Institute for Applied Systems Analysis (IIASA) before joining the faculty at Princeton University in 1976, where he would spend his entire academic career.

Impact was felt not only through his research but also through his professional service to the global scientific community and through his mentoring of more than 30 PhD students and a similar number of postdocs and research staff. Across his entire career, a characteristic of Eric's approach to research was extensive collaboration, and by joining forces with a global network of leading researchers he was able to make significant advancements and remain at the forefront of the field.

When not working on his research or travelling around the world to conferences and to collaborate with international colleagues, Eric was an avid fisherman, hunter, and skier. He regularly travelled back to British Columbia, Canada for annual salmon fishing trips with friends, ski trips at Whistler and enjoyed deer hunting in upstate New York. He loved cooking, good wine, and played a mean game of cribbage.

Eric died on November 3, 2021 after a multi-year battle with cancer at the age of 74. He is survived by his siblings John, Elizabeth, and Peter, former spouse Katharine, children Alex and Emily, and grandchildren Clementine, August, Elliott, and Silas.

With thanks to the New York Times and Princeton University.

Dr Laszlo Nemes FTSE

Dr Nemes was a major contributor in advanced manufacturing, particularly relating to automatic control and enterprise integration.

Born in Hungary on 28th December 1937 Laszlo suffered extreme trauma at age 7 in Bergen-Belsen concentration camp with his mother, sister and baby brother. Luck saved them from Auschwitz. During months of starvation Laszlo nearly died of influenza.

He was awarded an MSc in Mechanical Engineering in 1964 from the Technical University of Heavy Industries, Miskolc, Hungary; a Postgraduate Diploma in control engineering from the Technical University, Budapest, Hungary in 1969 and, in 1981, he earned a Hungarian Academy of Sciences "Candidate of Sciences" (PhD equivalent) qualification for research in Computer Applications in Manufacturing. In 1986 the University of Heavy Industries, Miskolc bestowed a "Doctor Universitatis" (Hon. DSc or DEng equivalent).

From 1974 he was Head of Division for Automation of Machine Industry of MTA SZTAKI (Institute for Computer Science and Control of the Hungarian Academy of Sciences), researching integrated manufacture, computer-aided design, robotics and factory automation. Outcomes were applied by manufacturers in Hungary and other countries.

In 1986 the CSIRO Division of Manufacturing Technology invited Dr Nemes to lead the Intelligent Manufacturing group. He migrated with his then wife and two young children. He quickly established contacts with Australian industry, universities and other CSIRO divisions.

He was a key player in forming the Australian CRC for Intelligent Manufacturing Systems and Technologies; while, internationally, he worked to form the Intelligent Manufacturing Systems program, involving Australia, Canada, Europe, Japan and USA.

Dr Nemes was elected an ATSE Fellow in1997. He served on engineering advisory committees for ANU and RMIT University.

Laszlo died on 1st December 2021 aged 84. He is sadly missed by his partner of 12 years and his daughter, son and 4 grandchildren.

Professor Barry Stephen Thornton AM FTSE

Professor Thornton was a pioneer of Australian computing who helped make stealth jets invisible to making breast cancer cells easier to see.

Born in Sydney 1930, Barry spent his childhood in Great Depression food queues with his mother and playing in hand-made billy-carts on the steep Coogee streets.

He obtained his PhD from University of NSW and a Doctor of Science from Sydney University. After a brief time as an actuarian, Professor Thornton became an eminent aeronautical engineer. He worked on one of the first commercial computers in Australia.

His innovations include safer airborne computer controls, military aircraft that can't be seen by radar, quieter commercial jet engines. He modelled the flutter in helicopter blades and the setting of yacht sails under differing conditions.

In 1974 he was named the inaugural Dean of Mathematical and Computing Sciences at NSW Institute of Technology, which became the University of Technology Sydney in 1988. Professor Thornton's other roles include the Director of Technical Operations for Honeywell Australia, a research officer at CSIRO, a senior lecturer at the UNSW and a Professor of Physics at the University of Sydney.

A master of creatively applying new knowledge across disciplines, he adapted insights from his radar research to advance infrared mammogram techniques.

Professor Thornton founded the Foundation for Australian Resources, where he oversaw research into water pollution in mining, landmine mapping, solar energy planning, and breast cancer imaging. He was one of the early research professionals to advocate telemedicine and the use of digital technology in healthcare.

His passion for changing lives continued into his later years, when he studied tumours cells and Alzheimer's disease, which his wife for 48 years, suffered from.

Professor Thornton's many honours include an Order of Australia in 1997 and his election to the Academy in 1994.

He died on 28 December 2021, two months after his wife Fae. He is survived by his daughter and three granddaughters.

With thanks to Elysia Thornton-Benko and The Sydney Morning Herald

Mr Bruce Kean AM FTSE

Bruce Kean was born in England in 1993 and came to Australia in 1950. He was educated in Melbourne where he studied chemical engineering and economics. He served in the Australian Army (CMF) from 1951, in The Royal Corp of Signals and later The Intelligence Corps. He retired in 1970 with the rank of a Major.

He joined Boral Ltd in 1968, after working for 17 years with The Gas and Fuel Corporation of Victoria in a wide range of positions. Mr Kean was appointed Chairman of Oil Company Australia in May 1987 and Chief Executive and a Director of Boral Ltd in June 1987. He retired from both roles in January 1994.

Bruce's involvement with Committee for Economic Development of Australia (CEDA) began in 1968. He would go on to serve on the CEDA Board before being appointed Chairman in 1994, a role he undertook until 2002. He would later become an Honorary Life Trustee. He made an outstanding contribution to CEDA during his time with the organisation. His years at the helm of the organisation were transitional ones, influenced by big technological and societal changes taking place at the time.

In February 1994 he was awarded the Order of Australia for his service to Industry. In November 1994 he was the recipient of the Sir John Allision Award for achievements in Export and Trade.

He became an ATSE Fellow in 1995 and went on to serve as Chair of the ATSE Clunies Ross Awards Committee and the ATSE Audit and Risk Committee. In 2013 he received the ATSE Medal to mark his long service to the Academy.

He brought his vision, expertise and dynamism to ATSE policy Forums including the Climate Change, Energy and Industry & Innovation Forums. Bruce made an outstanding contribution to ATSE and assumed a key role in transforming ATSE into the organisation it is today.

Dr Neville John McCarthy AO FTSE

Dr McCarthy, born 1929, was a leader in the pharmaceutical sector and one of the founders of Australia's biotechnology industry.

As the Second World War reached its crescendo, the 15-year-old Neville McCarthy met a girl on the train to school. He and Margaret — a future pianist and educator — were married in 1952 and would go on to have five children.

Neville completed his medical studies at the University of Melbourne and the young the family moved to the small Victorian town of Yarrawanga, where he became a popular local GP.

But in 1968 deafness caused by an inherited inner-ear disorder forced Dr McCarthy to leave his practice. He returned to Melbourne, changed career, and was appointed Australia and Pacific Managing Director of Squibb, a global pharmaceutical manufacturer.

In 1974, Dr McCarthy became CEO of Australia's largest biopharmaceutical firm Commonwealth Serum Laboratories (CSL), which was publicly owned until 1994.

Under his 16-year leadership CSL grew from strength to strength, making historic contributions to the medical field including life-saving snake bite treatments and world-first processes to protect donated blood from HIV infection.

Dr McCarthy was named an Officer of the Order of Australia in 1984 and was elected a fellow of ATSE in 1988. He was a member of the health forum.

In 1993, Neville and Margaret's youngest son Robert, a talented veterinary scientist, tragically died from cancer. The family established the Robert Neville McCarthy Scholarship in his honour, which supports students through the University of Melbourne's Doctor of Veterinary Sciences program. The fund has recently been expanded to help a broader range of students.

Dr McCarthy chaired numerous medical organisations; helmed human and animal health programs in Australia and abroad; and championed local research and development in fields including genetic engineering.

Neville McCarthy died on 13 November 2021 aged 92, seven years after Margaret. He is survived by his children Elizabeth, Gavan, Jennifer and Neil, and his grandchildren.

With thanks to the University of Melbourne

Dr Warren Hewertson FTSE

Dr Hewertson was known to be accomplished, caring and extremely knowledgeable by his family and peers. He made lasting contributions to everyone he worked with and held senior positions with ICI in England and CSIRO in Australia.

Dr Hewertson was born in Lancaster, England in 1937. He grew up helping his father's building business working with wood and making ladders, this early experience was influential later in life and is reflected in his career path.

He had always been incredibly focused and commitment to his studies, and could often be found at home in a warm cosy place to study well away from the hustle and bustle.

Warren studied at Nottingham University completing a chemistry degree and later completed his PhD at London University. In May 1961 he was invited to undertake postdoctoral research at Indiana University in the United States of America.

He was a great mentor to all he worked with and possessed a genuine desire to see others succeed. In 1983 he received an offer from CSIRO where he was appointed chief of the forestry division and worked with CSIRO for the next 16 years.

During his time there, Dr Hewertson was known for his outstanding managerial skills towards his division and played an important part in uniting forestry and forest products research in Australia, and served with distinction on many industry, government, and research committees.

Dr Hewertson was elected as a Fellow of our Academy in 1991, and during his time he was actively engaged with ATSE. Retiring as a Chief of the CSIRO Division of Forestry and Forest Products, he has helped shape the work and made a lasting contribution to ATSE and Australia.

Dr John Pitt FTSE

Dr Pitt was one of the most eminent scientists to emerge in the Food Mycology area as an expert on Penicillium taxonomy and a pioneer of research on spoilage moulds in a range of foodstuffs.

Dr Pitt was born on a small property at Wamberal, on the Central Coast of NSW. He grew up on a farm and had significant knowledge of fruit and vegetable crops, although was not interested in continuing in the family business. On 1st March, 1954, just before his 17th birthday, Dr Pitt joined CSIRO as a Technical Assistant Grade 1 (Junior). Over time, he slowly moved up through all research grades, reaching Chief Research Scientist in 1992, at the age of 55. He appears to be the only CSIRO employee to have ever achieved the feat of moving up from TA to CRS.

While working, he attended the University of New South Wales part-time to complete his higher education, studying Food Technology. His fascination with science resulted in him undertaking an MSc qualifying course at UNSW, and then a part-time MSc, entitled "Microbiological Problems in Prune Preservation". The cemented his interest in the world of fungi. He subsequently carried out a full time PhD at the University of California, Davis, studying yeast taxonomy, and a postdoctoral year at the USDA Northern Regional Research Center, Peoria, Illinois (NRRL).

In the 1970s to 1990s, he carried out pioneering work on methods for isolating and identifying food-borne fungi. The work on food mycology was complimented with mycotoxin research and the possible methods for minimising aflatoxins in peanuts. This approach has become of world-wide interest with several commercial products now available.

He completed 65 years of service to CSIRO in March, 2019. He authored, co-authored, edited or co-edited 20 books, and published 250+ research papers and book chapters, 70 of them published since he officially retired in 2002.

After a lengthy battle with lymphoma, John died in the early hours on the 28th of March 2022. His contribution to mycology and his many achievements will continue to inspire.

With thanks to CSIRO & the British Mycological Society.

What we're reading

Recommendations by new Fellows 2021

Looking for an intriguing read to expand your mind this winter? We asked some of our new Fellows to suggest books they've recently enjoyed, and why they recommend them.

Professor Marcia Langton
AO FTSE FASSA

Associate Provost, University of Melbourne

The First Astronomers: How Indigenous Elders read the stars

Duane Hamacher with Elders and Knowledge Holders

Between the covers of this extraordinary book is a detailed account of the science behind Indigenous star knowledge. Rarely is a book of such importance published. The idea that the only true science is that of Western thinking must be consigned to history. Those who read this book will understand why.

Professor Ken Baldwin
FTSE

Inaugural Director of the ANU Energy Change Institute

Transitioning to a Prosperous, Resilient and Carbon-Free Economy

Edited by Ken Baldwin and others.

As a bit of a plug, I would recommend the book that we've just published with Cambridge University Press: a comprehensive manual for decision-makers and policy leaders to address human-induced climate change, including both climate change mitigation and adaptation, with a forward by former Australian Prime Minister, the Hon Malcolm Turnbull.

Professor Karen Hapgood
FTSE

Deputy Vice Chancellor Research, Swinburne University of Technology

Where You Are Is Not Who You Are

Ursula M Burns

Ursula was the first Black female CEO of a Fortune 500 company. This memoir of her life and working her way up from a mechanical engineer to the top of Xerox is fascinating. Her frank analysis on effective working culture and diversity is amazing.

Dr Sue Keay
FTSE

CEO of Queensland AI Hub and Chair of Robotics Australia

The Bomber Mafia

Malcolm Gladwell

I'd recommend this for understanding some of the real-world challenges of adopting technology, and why a compelling vision and the "best" technology do not always meet with success.

Dr Michael Robertson
FTSE

Acting Director of Health & Biosecurity at CSIRO

Farmers or Hunter Gatherers?

Peter Sutton and Keryn Walshe

A thoughtful critique of the Dark Emu debate by two experienced anthropologists that adds further richness to mainstream understanding of the relationship between First Nations people and landscape and food procurement.

Dr James Johnson
FTSE

CEO of Geoscience Australia

The Narrow Road to the Deep North

Richard Flanagan

This book comprises a set of sub-plots, stemming from the experiences of WWII Australian prisoners of war in Burma, that interweave perfectly at the end. One of the best novels I have read.

Printed on ecoStar+ 100% recycled.
Made with 100% recycled post-consumer waste.

ecoStar+ is an environmentally responsible carbon neutral paper, and the fibre source is FSC CoC (Forest Stewardship Council — Chain of Custody). ecoStar+ is manufactured in a process chlorine free environment under the ISO 14001 environmental management system.

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Printed using vegetable based low VOC (Volatile Organic Compounds) inks.

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A tech powered human driven future

25-27 October 2022
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