Issue 04 | April 2018

Minds&Hearts

STEM SPOTLIGHT

Gravitational Waves

Quantum Computing

Virtual Reality

Biomechanics

FULBRIGHT
AUSTRALIAN–AMERICAN
FULBRIGHT COMMISSION

The Fulbright Program

The Fulbright Program is the flagship foreign exchange scholarship program of the United States of America, aimed at increasing binational collaboration, cultural understanding, and the exchange of ideas.

Born in the aftermath of WWII, the program was established by Senator J. William Fulbright in 1946 with the ethos of turning 'swords into ploughshares', whereby credits from the sale of surplus U.S. war materials were used to fund academic exchanges between host countries and the U.S.

Since its establishment, the Fulbright Program has grown to become the largest educational exchange program in the world, operating in over 160 countries. In its seventy-year history, more than 370,000 students, academics, and professionals have received Fulbright Scholarships to study, teach, or conduct research, and promote bilateral collaboration and cultural empathy.

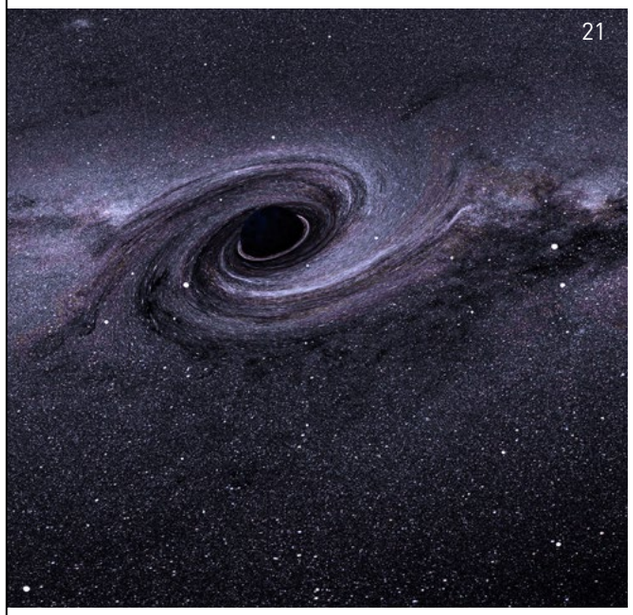
Since its inception in Australia in 1949, the Fulbright Commission has awarded over 5,000 scholarships, creating a vibrant, dynamic, and interconnected network of Alumni.

Our future is not in the stars but in our own minds and hearts.

Creative leadership and liberal education, which in fact go together, are the first requirements for a hopeful future for humankind.

Fostering these—leadership, learning, and empathy between cultures—was and remains the purpose of the international scholarship program that I was privileged to sponsor in the U.S. Senate over forty years ago. "

Senator J. William Fulbright
The Price of Empire



Contents

Cover Image courtesy CaltechMITLIGO Laboratory

Andrew Blyth (2012, UNSW Canberra to the University of Texas at Austin) authored a chapter in the newly-released book; *The Ascent to Power, 1996: The Howard Government Volume 1.* The book takes a critical look at the Howard Government's rise to power; its policies and priorities, successes and shortcomings.

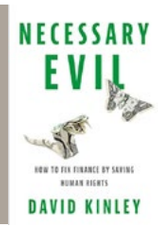
Miriam Shiffman (2013, Pomona College to the University of Queensland) co-authored an article explaining why microbial communities present in the digestive tracts of koalas enable them to digest the leaves of Eucalyptus trees.

Tony Weiss (1984, University of Sydney to Stanford University) was awarded the Order of Australia for service to science in the field of biotechnology, as an academic, researcher, author and mentor, and through executive roles with scientific institutions.

Johannes Drielsma (1991, University of Tasmania to Yale University) was appointed to the Order of Australia for significant service to the commercial forestry industry, to sustainable management practices and certification programs, and to professional bodies.

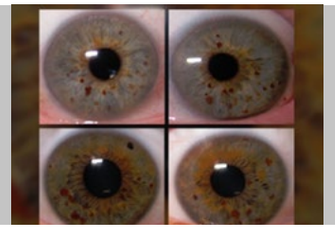
Robert Mason (2013, University of Queensland to University of Hawaii) published an article on ocean acidification (OA) in *Royal Society Open Science.* OA is predicted to reduce reef coral calcification rates and threaten the long-term growth of coral reefs under climate change.

Robert Park (2010, University of Sydney to United States Department of Agriculture) developed a new DNA test that can quickly detect the disease and help farmers deal with wheat rust; a devastating disease affecting wheat crops in Africa and Europe. His team's findings were published in *Science.*



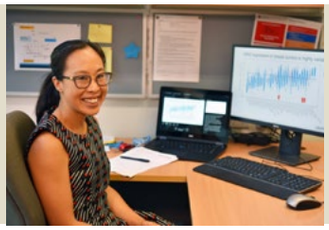
David Kinley (2003, Monash University to American University) released a new book, *Necessary Evil,* outlining a way forward for cooperation between government and finance that can promote human rights and social justice.

Elizabeth Berry (2009, Washington and Lee University to Queensland Institute for Medical Research) published an article in the *British Journal of Dermatology* finding that pigmented lesions on the iris ('iris freckles'), are associated with a 45 per cent increased risk of melanoma.



Kristen Walker (1997, University of Melbourne to Columbia University) was appointed to the post of Solicitor-General for Victoria by the Andrews Labor Government.

Jessica Mar (2003, the University of Queensland to Harvard University) was awarded a $50,000 Metcalf Prize to expand her research and introduce the next generation of stem cell researchers to the power of 'centenarian studies'.



Sean Reilly (2016, Santa Clara University to The Djunbunji Land and Sea Program) received a Rhodes Scholarship to complete a master's degree in mathematical modelling and scientific computing and in environmental change and governance at Oxford University.

David Bishop (2016, University of Technology Sydney to University of California Los Angeles) and **Stephane Shepherd** (2015, Swinburne University of Technology to University of Nebraska-Lincoln) were both awarded Discovery Early Career Researcher Awards. David's work investigates quantitative three-dimensional imaging of membrane proteins, while Stephane will be looking into advancing cross-cultural approaches to violence risk assessment.

2018 Fulbright Gala Presentation Dinner - Over 400 delegates from higher education, government, academia, business, and the Fulbright alumni community gathered at the Great Hall of Parliament House, Canberra for the 2018 Fulbright Scholar Presentation Gala Dinner. The events included an orientation for the newest Fulbrighters, a Scholar Showcase event, and a formal awards dinner, where each scholar was officially inducted into the Fulbright community.

Monash University Vice Chancellor and Fulbright Alumna Professor Margaret Gardner addressed the scholars at one of their orientation seminars. Professor Gardner talked about her own experiences on exchange at the Massachusetts Institute of Technology, and offered some words of advice to our scholars on how to make the most of their international education opportunities.

Australian Government Minister for Foreign Affairs the Hon Julie Bishop opened the Scholar Showcase with words of support on behalf of the Department of Foreign Affairs and Trade (DFAT). She commended the scholars for their achievements, and wished them the best for their Fulbright journeys.

U.S. Charge d'Affaires James Carouso reaffirmed the American commitment to Fulbright, highlighting the new Fulbright Scholarship in Australia-United States Alliance Studies, co-sponsored with DFAT. The award will enable two Australians and two Americans to undertake programs of bilateral research or study in the 2018/19 academic year.

Australian Government Minister for Education Senator the Hon Simon Birmingham met with several of the scholars, before delivering remarks on behalf of the Prime Minister.

"William Fulbright said that bridges can be built across the chasm of ideology...he was envisaging bridging those chasms in the face of what was seen as profound ideological differences and battles that occurred around the world."

Chair of the Fulbright Commission Board of Directors, Mr Peter de Cure thanked all of the Fulbright sponsors, and announced three upcoming scholarships, including the Fulbright Future Scholarships, funded through a generous $10 million philanthropic donation from the Kinghorn Foundation.

Chair of the Fulbright Foreign Scholarship Board and former U.S. Ambassador to Australia Mr Jeffrey Bleich delivered an engaging keynote speech on 'Technology, Truth, and Trust'. The full text can be read in full later in this edition of *Minds & Hearts*.

Executive Director Thomas Dougherty as MC

Fulbright alum Michelle Deshong delivers an Acknowledgement of Country

2018 Fulbright Scholars meeting with Foreign Minister Julie Bishop

Over 400 guests attended the Dinner

National Archives Director David Fricker presented Jeff Bleich with a commemorative frame

A Brighter Future for Australian Researchers

The Australian-American Fulbright Commission is pleased to announce a new program of bilateral exchange scholarships, designed to improve the health, well-being, and prosperity of Australians by funding innovative, impact-focused research.

The FULBRIGHT FUTURE Scholarships, funded through a generous $10 million donation from The Kinghorn Foundation, will fund bilateral study and research projects that aim to advance cutting-edge applied science, facilitate innovative business collaborations that foster the creation of new jobs, and further the development of impact-driven emergent technologies.

The new program is set to become the most comprehensive and generous of the Fulbright catalogue, with the awards covering travel and living expenses, as well as the full tuition costs or visiting researcher fees at any U.S. university.

Fulbright Executive Director Thomas Dougherty said the new program has the potential to create linkages crucial to Australia's reputation as a driving force in research and technological innovation.

"Fulbright has been a conduit for facilitating bilateral connections for over 70 years." He said.

"With this new program we aim to provide a whole new suite of opportunities for international education and research collaboration, as well as helping to bridge the gaps between industry and academia."

The FULBRIGHT FUTURE Scholarships are open to Australian postgraduate students, postdoctoral candidates, academics and professionals from 1 February 2018.

FAQ

- **When will applications for the new scholarships be open?** 1 February, 2018
- **Who is eligible to apply?** Australian postgraduate students, postdoctoral candidates, academics, and professionals
- **Where can I find more information?** www.fulbright.org.au/scholarships/future/

A Century of Australian-American Mateship

2018 will see the launch of four one-off Fulbright Scholarships to enhance and strengthen our understanding of Australia-U.S. relations.

The **Fulbright Scholarships in Australia-U.S. Alliance Studies** were announced by Foreign Minister Julie Bishop as a feature of the Australian Government's 'First 100 years of Mateship' campaign, marking a century of bilateral partnership in war and peace. Co-funded by the Department of Foreign Affairs & Trade and the U.S. State Department, the awards will enable Australian scholars to pursue short-term study in U.S. universities, and vice versa.

This investment celebrates a relationship of vital importance to both countries, and serves as a further contribution to the strong ties among our universities and scholars. In 2016, over 10,000 American students studied in Australian educational institutions, and close to 5,000 Australians studied in the U.S.

Each year this bilateral knowledge-sharing grows, as more of our world-class educational institutions produce exceptional candidates for academic exchange.

The Fulbright Program, as the flagship foreign exchange program of the U.S, has acted as a conduit for these connections for nearly seventy years, awarding over 5,000 scholarships to candidates from both countries since it commenced in Australia in 1949.

These scholarships will be a fitting tribute to these links, and to 100 years of Australian-American ties forged in shared struggle.

This year, both countries commemorate the centenary of the Battle of Hamel, in which Sir John Monash became the first non-American to command U.S. soldiers in an offensive action.

Foreign Minister Julie Bishop meets with then-U.S. Secretary of State Rex Tillerson during the 2017 AUSMIN meetings
Image: Associated Press

TECHNOLOGY, TRUTH, & TRUST

2018 Fulbright Gala Presentation Dinner Keynote Speech

JEFFREY BLEICH

Thank you, Fulbright Scholars and Students. Ambassadors, Ministers, Consuls General, Admirals, Generals, Parliamentarians, Aunties and Elders, and most of all those who have no titles but who give so much to support Fulbright and its values. Ghandi and Dr. Martin Luther King, Jr. did not have a title. Lindsay and Paula Fox do not have titles.
And yet, you have helped change the world by being magnificent citizens.

I am deeply honored to join you all tonight in celebrating the U.S-Australia Fulbright exchange, during this 100th anniversary of the mateship formed between our two nations at the Battle of Hamel.

This relationship between our nations means everything to me, and Fulbright is its crown jewel. I had the rare privilege of co-chairing this Commission with three Prime Ministers. [Four if you count Kevin Rudd twice]. That experience inspired me to join the worldwide Fulbright Board in America and serve as its chair. So my heart is full of gratitude to you for many reasons.

But most of all, I want to thank you all for giving me this chance to be 15,901 kilometres away from Washington DC tonight.

There are of course many things that could be said about the state of American politics today. I wish I could tell you all what they are. But of course we Americans won't really know, until High Commissioner Downer fills us in.

My topic tonight is the three Ts. And that is not "Trump twitter tirades." At the core of Fulbright, and the U.S.-Australia Fulbright exchange are technology, truth, and trust. We share our best and most innovative minds because we believe that technology should serve all humanity, that truthful exchange is essential to all human progress, and that trust is the most potent weapon against war. To me, these three principles require more international attention and engagement today than ever before in my lifetime.

Bonds are often born from crisis. The U.S. and Australia relationship was forged in the heat of two terrible wars. That experience, and the trust we formed, lead to our first treaty. Having endured the savagery of war, our first impulse though was not to form a treaty alliance to fight again. Our first treaty instead was Fulbright. Before we would enter into an alliance to declare war, we first formed an alliance to create peace.

Our pact was to wage *peace* -- to fight the conditions that would make future wars likely.

Together we sold off our surplus weapons of war, and used the proceeds to fight ignorance, intolerance, and lies. We sent our best and brightest young people to each other's shores: to meet new people, to learn new things, to share facts and skills, and build the deep and supple connections that last a lifetime. We shared technology that improved us; we found common truths that bound us, and we built the trust that protects us.

Fulbright wrote: "Educational exchange is not merely one of those nice but marginal activities in which we engage in international affairs, but rather, from the standpoint of future world peace and order, probably the most important and potentially rewarding of our foreign-policy activities."

Today, 70 years later, the pillars that make Fulbright such a tremendous force for peace are all being rocked, and we feel the shockwaves around the world. There has never been a more important time to rededicate ourselves to this mission.

So let me begin with Technology.

Technology

We are going through one of the most extraordinary technological revolutions in human history. Thanks to a device that you all have in your pocket or purse tonight, everyone in this room is a disrupter.

You click a ride-share app and you upend the taxi industry.

You click a house-share app and you upend the hotel business.

You buy an item on Amazon and you upend the retail business.

Every person in this room is a news channel -- capable of reaching millions of viewers -- and reshaping news. Even while we sleep, the data we throw off from our trackers and fitbits and IOT devices, are producing insights that will create even more disruption.

Change is happening to us and from us. And it is happening at a dizzying speed.

Today, 70 years later, the pillars that make Fulbright such a tremendous force for peace are all being rocked, and we feel the shockwaves around the world.

There has never been a more important time to rededicate ourselves to this mission."

The challenge is that this technology is moving so fast that we have no idea where it is taking us. In 1949, we realized the technologies we'd created to quickly end a World War could become the source of an even greater and more devastating nuclear war. Technology is supposed to serve human needs and aspirations. It should not overwhelm or undermine or end humanity.

At this moment, we can't tell where many of these new technologies will take us. How do we ensure that these technologies will allow *all* of us to lead better lives -- not just some of us? How do we ensure that robots relieve us of drudgery rather than relieve us of purpose? How do we ensure that the information age improves our understanding, rather than overwhelming it.

It is moments like this when we feel the true worth of Fulbright.

We share our best minds with humility.

We send them abroad because we know we do not have all the answers.

We all need our best minds to stretch out across the world with the purpose of gaining new insights to answer unsolved mysteries.

The minds that are producing disruption need to go out to disrupted spaces to answer a different question. Not where technology *could* take us, but where it *should* take us.

Einstein said: "No problem can be solved by the same consciousness that created it. We need to see the world anew."

Being in a different place makes us think differently. Think of what it is like when you travel some place for the first time. We go somewhere we've never been before -- and we see it with fresh, intense eyes.

We are more aware of the way the air smells, of the color of the sky, of the taste of the foods, or the wildlife around us. We learn a different language and we discover words for thoughts that had not yet been formed. We draw insights from people who were schooled and trained differently from us.

Travel disrupts old habits of thought; our prejudices and blind spots. And it removes our fears. We rediscover the humanity that binds us – that wherever we go, people want the same things.

We see the nations we visit differently, and when we return home, we see our own nation differently. This is what Einstein meant when he said: "we need to see the world anew."

At a moment when technology is overtaking humanity; when we look at our devices more than into each other's eyes; when we let bots define our debate; at this moment, exchange brings fresh humanity and minds to tame our technology.

"The minds that are producing disruption need to go out to disrupted spaces to answer a different question. Not where technology *could* take us, but where it *should* take us."

Truth

The second great challenge that requires Fulbright's leadership today is the assault on the truth.

One of the things I admired about my relationships here in Australia was the honesty of Australian leaders. It was not the silky diplomatic exchanges that made us work so well together. It was the direct ones. I vividly recollect a call from then-Secretary of Defense, Dennis Richardson. A redacted version remains in my mind. It was: "If you [blank]s think that you can [blank]ing [blank] us by [blanking] up this deal, I swear we will [blank] your [blank]ing [blank] off."

In all of my time as Ambassador in Australia, I never doubted that my Australian counterparts were expressing their true inner feelings. We occasionally drew different conclusions, but we always trusted that we could agree on the facts.

That is also the ethic of Fulbright. Scientists may speak different languages but their equations -- the facts on which their findings are built -- are a common language. The same is true in math and in music. Numbers, notes, scientific symbols, code -- these are common languages. A note is the same no matter how it is expressed. An equation proves or it does not. An experiment solves or it does not. Scholars from different backgrounds and beliefs solve common problems through the common language of facts.

Truth matters. In Fulbright's day, vast populations descended into violence when they became convinced of cruel lies, or when they could no longer tell the difference between lies and the truth. People peddling the false science of Eugenics convinced others that Jewish people, Gypsies, people with disabilities, and people of color were somehow subhuman. And men coldly slaughtered other men, and performed cruel experiments upon their own countrymen.

Others did not know what to believe. Reports of extermination camps and atrocities were discounted by the government as "fake news." And so they did not know what to believe. They believed nothing. And so they did nothing. Propaganda is a dark and dangerous contagion.

This is why Fulbright exchanges scholars, rather than athletes or some other group. It is because scholars' currency is objective, empirical fact. And nothing is more essential to society than facts.

Russia's disinformation campaign demonstrates this today.

In the last U.S. election, Russian operatives did not merely put out a pro-Conservative narrative, or a pro-Liberal narrative. They did something far more sinister.

They did both. They distorted both.

They created a space in which Americans came to doubt the most basic things about one another, and became willing to believe the worst about each other. Bots and fake news sites created the impression that members of both parties were doing unspeakable things. Thousands of conservative Americans were convinced that Hillary Clinton, while running for President, was also operating a child sex ring in the basement of the Comet pizza parlor in DC. Millions of Americans were convinced that the First Lady was actually a man named Michael. Millions believed the birther lie.

These are not issues of opinion. The pizza parlor either had a basement filled with child sex slaves or it didn't. Michelle Obama is either a woman or she isn't. Barack Obama was either born in Hawaii or he wasn't. It either rained at the 2017 inauguration or it didn't. These are not things open to disagreement. They are facts.

When it gets too hard to know the facts, this is when societies collapse. Once people do not know what to believe, they can no longer make decisions, and eventually they simply go along uncritically. They will stick with whatever reality suits them.

Gun owners will buy more guns and arm teachers believing this really will reduce gun deaths. Communities will burn fossil fuels rather than address climate change, because they believe it is only a Chinese hoax, after all. They will distrust people they do not know and places they have not been. And they will proliferate those lies -- online, on t.v., in the airwaves, until there is no distinction between truth and lies.

The antidote is Fulbright -- to send truth-tellers around the world.

If you are with Michelle Obama in person, she is definitely not a man. If you were in DC for the last inauguration, you would definitely have gotten wet. If you went into the basement of the pizza parlor in DC, you'd know that there is no basement to that pizza parlor in DC.

Truth-tellers -- mathematicians, scientists, musicians -- return from places and can tell people objectively what they saw and experienced and learned, and restore critical and analytical minds.

Mark Twain -- a great traveler and lover of Australia -- wrote of travel that it "is fatal to prejudice, bigotry, and narrow-mindedness... Broad, wholesome, charitable views of men and things cannot be acquired vegetating in one little corner of the earth all one's lifetime."

Sunshine is the best disinfectant. And Australia, you are the sunburned country.

You share our passion for bright light to expose lies and reveal truth.

Which brings me to my final point: Trust.

Trust

In a time when the pace of life is overwhelming and information is conflicting, trust is hard to sustain.

But societies are built on trust. It is the reason we all can drive home tonight after this event. We know that when we leave this venue for the hotel, there will be people driving 100 kilometers an hour in the opposite direction in deadly hunks of metal who could kill us simply by sliding a few feet across a small yellow line. But we trust that they won't. We believe that they love their life as much as we love ours, and that they will obey the laws the same way that we do. If we didn't believe that, we couldn't ever leave our homes.

Nations too are held together by trust. Being a citizen is not a one-day event -- the day you are born, or the day you are naturalized. It is an on-going process every single day. We actually expect a lot from one another: learning the issues, voting, holding leaders accountable, listening to opposing views, paying taxes, showing up for jury duty.

We will only do all of this if we believe most other people will as well. If you've ever been to a failed state, you know that they failed the moment they lost this faith.

We also need trust between nations. When a nation feels bullied, disrespected, abandoned, or distrusted, it will respond in kind. But if it is treated with trust and respect, it will also respond in kind.

Again, this is the spirit of Fulbright. You send us your best, and we'll send you our best. They will be safe in our country. We will connect them with our best schools and treat them well. And we will let them go home and tell you all about their experience. We earn trust when we extend trust.

So in that spirit of extending trust, I will conclude by doing two things that are forbidden in American politics today. Because I trust you. First, as a democrat seeking elective office, I am going to quote a Republican that I admire. And then as an American, I'm going to openly praise a country other than America.

The quote is from Republican Senator Richard Lugar of Indiana. He was a great public servant. And he said this about why he supported Fulbright:

"Maintaining alliances and friendships between nations is hard work. No matter how close allies become, centrifugal forces generated by basic differences in the size, location, wealth, histories, and political systems of nations tend to pull nations apart.

"Alliances work over long periods of time only when leaders and citizens continually reinvigorate the union and its purposes."

To me, alliances are like a marriage. If my wife Becky and I could name the one or two best things that happened in our marriage in the past year, that wouldn't be a good sign. These relationships are sustained only by the many small kindnesses, acts of appreciation, and tender mercies that we do without even thinking. We can never take spouses, friends, or allies for granted. Even if they are Republicans.

And the country I admire for this is you Australia: the Sunburned Country, the Lucky Country, the Land Down Under, you are a country that I love. My wife Becky and I brought three children with us here. Their lives since have been forever changed by that experience. They love both countries. It has made them curious about the world; open to the world; broader-minded, and wiser. When I think about the Fulbright effect, I think about them. I wish the same for each and every one of the Fulbrighters in this room tonight.

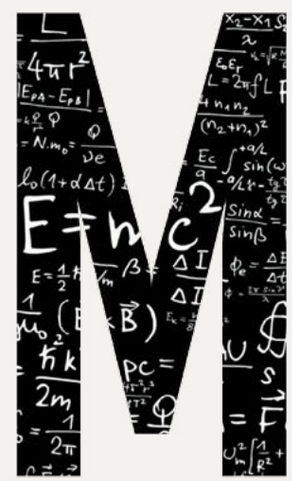
May you apply your skills for the good of all people. May you pursue the truth in all things. And may you discover the peace and security that comes from opening your heart 24 million souls wider.

Thank you, and God Bless America, God Bless Australia, and God Bless you all.

Science, Technology, Engineering, and Mathematics (STEM) fields are driven by discovery, as researchers strive to find new ways to improve our quality of life, and further our understanding of the world around us.

Some of the most fascinating discoveries are made when scientists take multi-disciplinary approaches, combining elements of various fields in creative and innovative ways.

In this issue, we're highlighting some of the incredible, multi-faceted STEM projects that our Fulbright Scholars are engaged in, across myriad disciplines including astrophysics, computer science, biomechanics, electrical engineering, and quantum physics.



QUANTUM LEAP

By the Editor

In a major departure from conventional computer technology, International Business Machines (IBM) Corporation today introduced its first computer using a main memory made entirely of monolithic circuits.

To store its data and instructions, the new IBM System/370 Model 145 uses silicon memory chips, rather than the magnetic core technology that has been the mainstay of computer memories for the past 15 years. The machine boasts an impressive 2.5 MHz of processing power, with 500 kilobytes of RAM and 233 megabytes of hard disk space.

Purchase price ranges from $US4.3 million - $US10.8 million - IBM press release, September 23, 1970

The Law of Accelerating Returns

THE computer has come a long way since 1970. The IBM System/370 was large enough to fill an entire room, but by today's standards, would only have enough processing power to store and access a small album of photos (and rather slowly at that).

By comparison, your most basic smartphone in 2018 is at least a thousand times faster, can store over 80 times the amount of data, and can be purchased with an average week's wages.

These drastic advances in capability and accessibility are largely due to our ability to create smaller and smaller integrated circuits that can store, process, and transmit data. As our manufacturing capabilities enabled us to further miniaturise the transistors that physically represent this data, we could fit more and more of them into the microprocessors that perform the critical functions of everything from the smallest handheld devices to the largest supercomputers.

Transistor count per chip has effectively doubled every eighteen months since the 70's - early microprocessors contained a few thousand transistors, whereas those found in smartphones and laptops today contain *billions*.

The more transistors, the more processing power, the more complex the logic operations that can be performed, and the more data that can be stored.

But advancement cannot continue at this pace forever. As populations grow, and advanced computer technology becomes ubiquitous, more powerful processors doing increasingly complex tasks will be added to electricity grids at an exponential rate, creating serious energy consumption concerns.

Further miniaturization will also present issues, as when the length scale of transistors reaches tens of *nano*metres, you actually only have a finite number of atoms to work with, and suddenly you're up against the enigmatic laws of quantum mechanics.

So what is the next step for computing? How do we continue creating smaller devices that can perform more complex operations, yet use less energy? One solution is to completely rethink the fundamental building blocks of circuits, exploiting quantum mechanical phenomena to create a revolutionary new device known as a ***quantum computer***.

> "...with 300 qubits, you could sustain more parallel computations than there are atoms in the universe."

The Quantum Leap

TO understand why quantum computers are such a huge deal, we should take a quick look at how classical computers work.

Traditional computing systems, such as the one I'm writing this story on, operate via binary code, assigning a pattern of digits to each character or instruction. The digits are known as 'bits' and can either be a '0' or a '1' (for example, a capital 'A' is encoded as '1000001', while a question mark [?] is '00111111').

Computers calculate by using circuits called logic gates, made from a number of transistors connected together, that compare patterns of bits stored in temporary memories called registers. These are then turned into new patterns of bits - essentially the computer equivalent of addition, subtraction, or multiplication.

Quantum computers, due to their quantum mechanical components, operate outside common, humanly experienced principles of their classical computing counterparts.

Rather than a binary system, where bits must be assigned one of two definite values, quantum bits (qubits) can be in a state of what is known as *quantum superposition*; in layperson terms, qubits can be either a '1' or a '0', or a mixture of *both* '0' and '1'.

Much like the 'wave-particle duality' of quantum theory, where a photon can behave like both a well-defined single particle, as well as a light wave spread out over space which may interfere with other waves, a single qubit can exist in a well-defined single classical state (i.e. 0 or 1), as well as a wave-state spread out over classical states that may interfere with other qubits.

Fulbright Scholar/quantum computer whiz Noah Johnson explains this notion using the (rather morbid) thought experiment known as *Schrödinger's Cat*.

"So there's this cat in a box with a small vial of poisonous radioactive material and a Geiger counter.

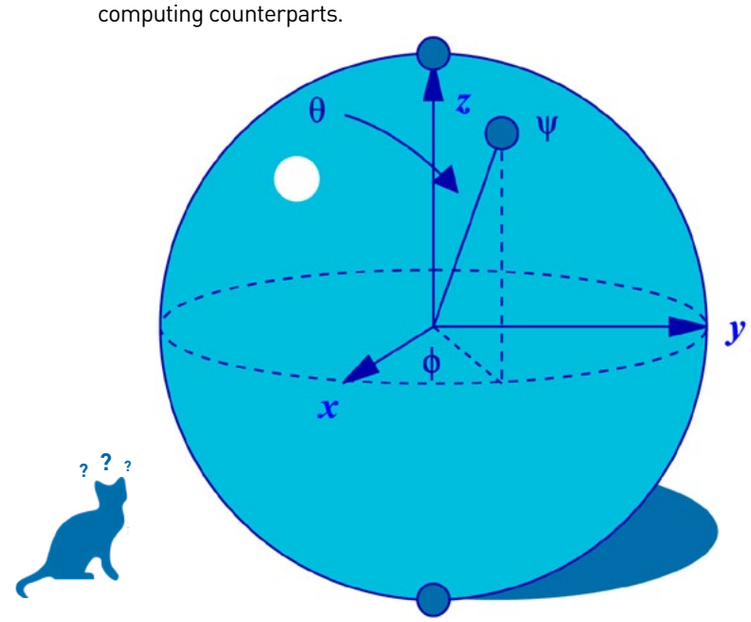
"Within the course of the material's half-life, there is a chance that the radioactive material has begun to decay, activating the Geiger counter, releasing the poison and killing the cat. However there is an equal probability that the material has not decayed, and the cat is still alive.

"The quantum mechanical side of this is, until you open the box and see it, technically you don't know whether the cat is alive or dead, so - in terms of quantum behaviour and superposition – the cat is actually both alive and dead at the same time.

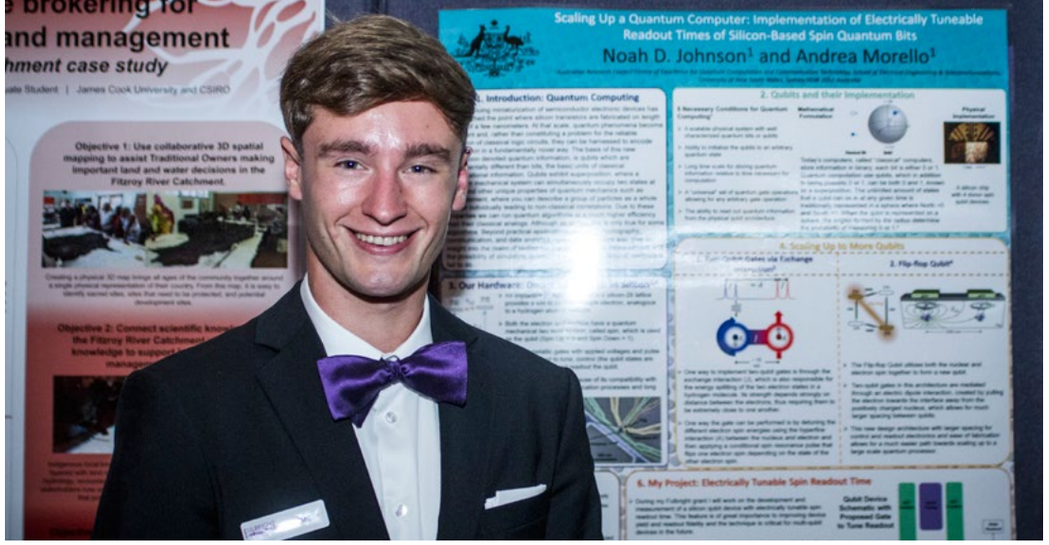
"So this is the same as these qubits; until we actually look at them, and read the information they're storing, they're simultaneously in '0' and '1', so you can encode a tremendous amount more data. With 300 qubits, you could, theoretically, sustain more parallel computations than there are atoms in the universe."

Have we lost you yet? Don't fret! One of the very few universally understood facts about quantum theory is that the classical laws of physics we take for granted in our everyday world no longer automatically apply.

What is important to understand is that qubits represent a revolutionary new technology for storing and processing data, enabling quantum computers not only to perform certain calculations much, much faster, but to also solve certain problems that would be fundamentally impossible on classical computers.



The Bloch sphere *is utilized to demonstrate how a quantum state may occupy an unlimited number of states (as opposed to the two classical two binary states, 0 and 1). The north pole of the sphere represents the classical state 1 and the south pole 0. The qubit is depicted as the point,* psi, *where the angles,* theta *and* phi, *formed by the radius, determine the proabability of measuring the qubit in either 0 or 1. Even Schrodinger's quantum cat is puzzled by the computational complexity.*



The Fulbright Connection

Here I should give Noah Johnson a proper introduction, as he is the reason I'm writing this article.

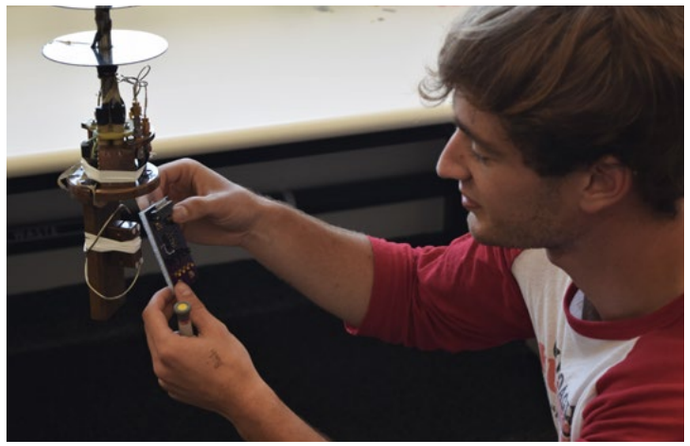
Noah is a Fulbright Postgraduate Scholar from the University of Wisconsin at Madison, where he majored in physics and mathematics.

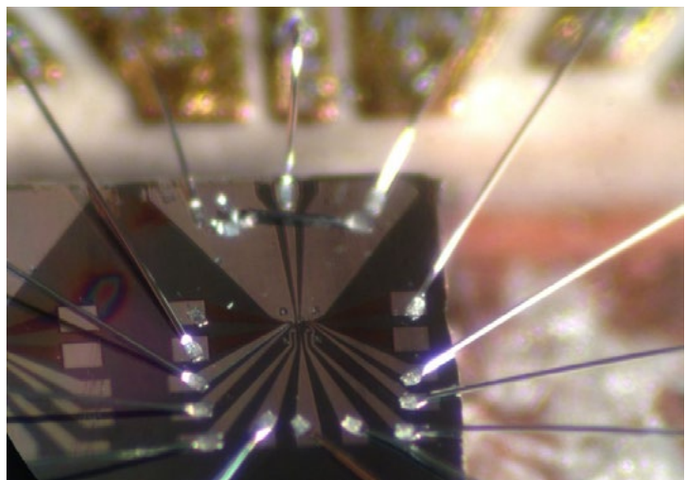
He is in currently in Australia, studying at the ARC Centre of Excellence for Quantum Computation and Communication Technology (CQC2T) at UNSW, under the globally renowned professor of Electrical Engineering and Telecommunications, Andrea Morello.

Late last year, Professor Morello's team announced the discovery of a novel architecture for the microscopic processors that will be used in quantum computers (quantum chips), potentially enabling them to be manufactured more cheaply and easily than previously thought possible.

Noah's work at CQC2T involves testing quantum chips at the near absolute zero temperatures required to avoid unwanted environmental interactions and to minimise errors.

This process, in itself, is pretty amazing.





> "If you look at a heat map of space, the coldest places in the known universe are right here on Earth, due to the extreme temperatures we need to artificially induce for these experiments."

"Andrea once told me that if you look at a heat map of space, the coldest places in the known universe are right here on Earth, due to the extreme temperatures we need to artificially induce for these experiments." Said Noah.

"The low temperatures enable us to accurately determine the specific quantum state of the qubit. We create the qubit levels by creating two states with different energy levels - temperature can be thought of as an average amount of energy in a system.

"So if the temperature is hotter than the energy difference of the qubit, then there is a chance the qubit can start to occupy the higher energy state when you don't want it to.

"Also temperature can lead to specific problems for us as we use a spin in a solid state system. Higher temperatures cause vibrations in the lattice of the crystal which can negatively couple to the spin system and destroy quantum information. In simple terms, you can think of these cryogenic systems as the equivalent of fans in your computer to dissipate unwanted heat."

The Quantum Conundrum

SO why don't we have mass-produced, consumer-priced quantum computers yet? Well, there are a number of barriers standing in the way.

Previously for a silicon spin-based quantum computer it was thought necessary to precisely place the atoms within silicon that would be used to 'trap' the electrons used for qubits. This is due to the proximity needed for coupling two qubits, and the large variations of this coupling that result if the placement is not correct.

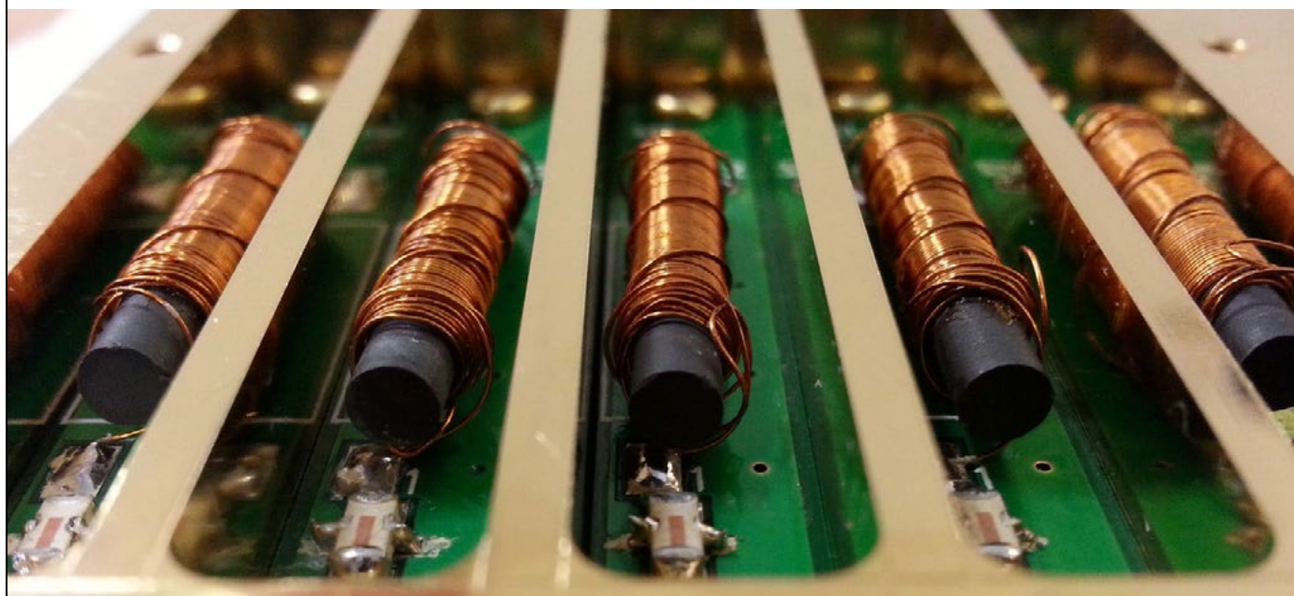
So it is difficult to foresee building up qubits in this way as room for the electronics needed to control and read out each qubit takes up a lot of space at this scale. Having a large array of closely placed qubits would require a new way of reading out and controlling individual qubits. Also, the fabrication of these devices with that accuracy is extremely difficult and expensive to achieve.

One solution is just getting better at placing atoms in a silicon lattice.

This is very difficult, but is currently being attempted by Scientia Professor Michelle Simmons - also at CQC2T. [At the time of publication, Professor Simmons' team announced a major breakthrough, witnessing the first observation of controllable interactions between two qubits.]

Another solution is the flip-flop qubit that Noah is working on, which uses both the electron and nuclear spin as the qubit. Utilising new methods (electric dipole interaction) to mediate coupling between two qubits allows for larger spacing between the qubits. This larger spacing allows for easier placement of all of the necessary electronics without worrying about more precise fabrication of devices. This way, you can rely on all the methods built up to control and readout single qubits while still having a method to couple larger numbers of qubits.

In layperson terms, this essentially means that the circuitry required for this quantum computer architecture could be manufactured more easily, cheaply, and quickly.



Images (from top left) Noah at the 2018 Fulbright Scholar showcase; Dilution Refrigerator -this houses the quantum chips cooling them to temperatures near absolute zero; Noah prepares a quantum chip for measurement inside one of the cryogenic cooling chambers; a magnified image of one of the quantum chips - the reflective metallic gates etched on the silicon substrate in addition to the non-visible phosphorus donor and electron comprise the qubit; an electrical component that is utilized to help prevent unwanted electromagnetic signals from reaching the qubit.

WHILE the flip-flop qubit idea is a huge breakthrough, an actual flip-flop qubit device has yet to be created and there are still some issues that need to be addressed.

"In our system, one thing that would be very helpful for scaling up from one qubit is a way to tune the read out time of our qubits.

"This would drastically help device performance and yield, which is increasingly important as our device fabrication processes become more complex. Many of the donors we implant in silicon are too far or close to our readout device which makes them unusable as qubits, but having a method to tune the readout time would allow us to use more donors and thus more devices.

"This could also allow us to tune the individual qubit readout times to better discern which qubit we are reading out in multi-qubit structures.

Translation: Noah is looking into ways to better calibrate the devices they use to read the data stored on the qubits.

This could help his team to scale up the manufacturing of the devices, as well as potentially creating a more efficient system.

"At this point in time we have a much greater understanding of the theory of quantum computation than the experimental understanding required for building a large scale quantum computer.

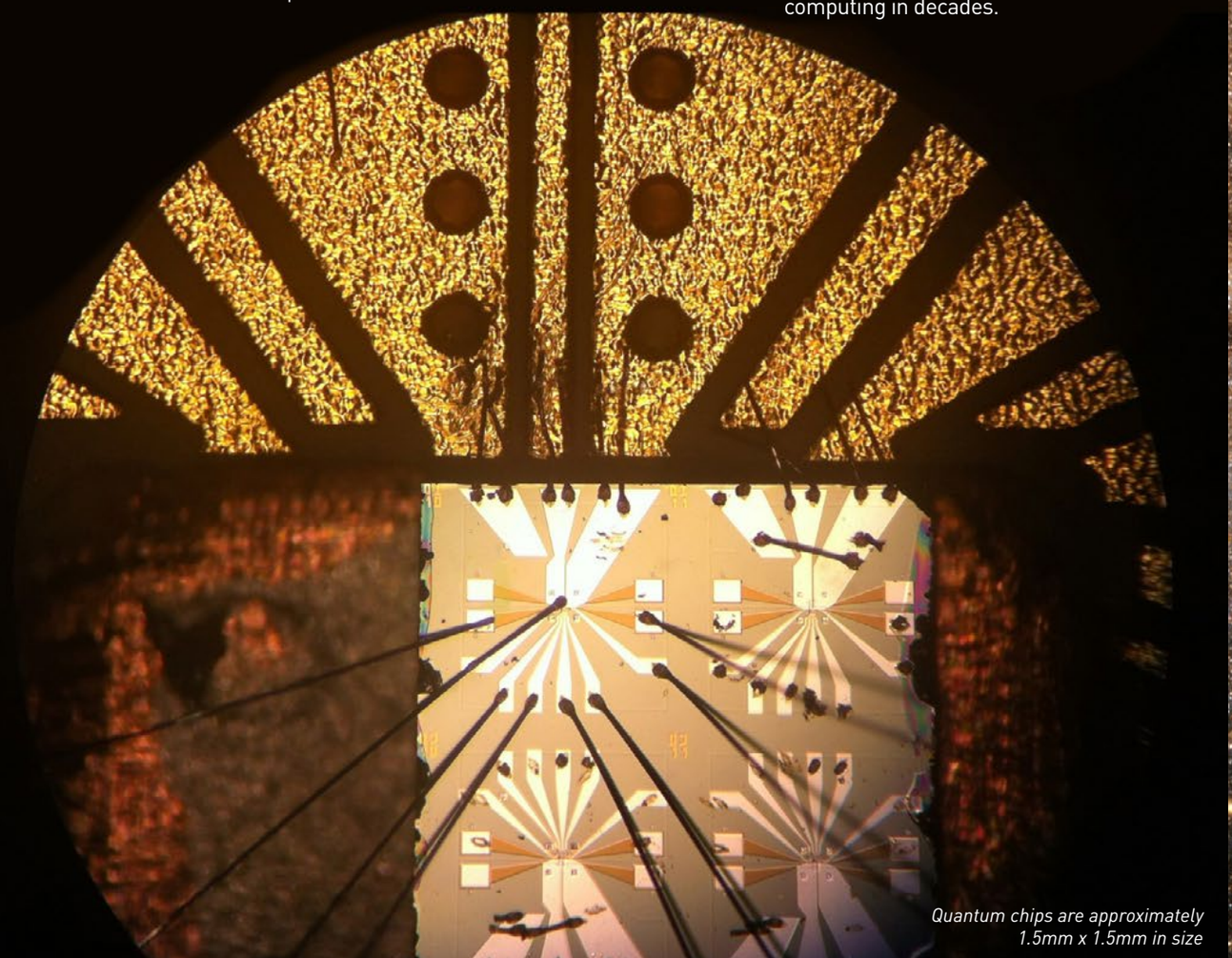
"This discrepancy is basically a result of the difficulty of trying to closely communicate with and readout the qubit to the user in the outside environment, while that same process introduces a large amount of possible error due to deconstructive interactions between the qubit and environment.

"This phenomenon, known as quantum decoherence, prevents a quantum system from interfering with itself and, as a result, destroys the possible superposition of a quantum states and causes a loss of the 'quantum' nature of information that we want."

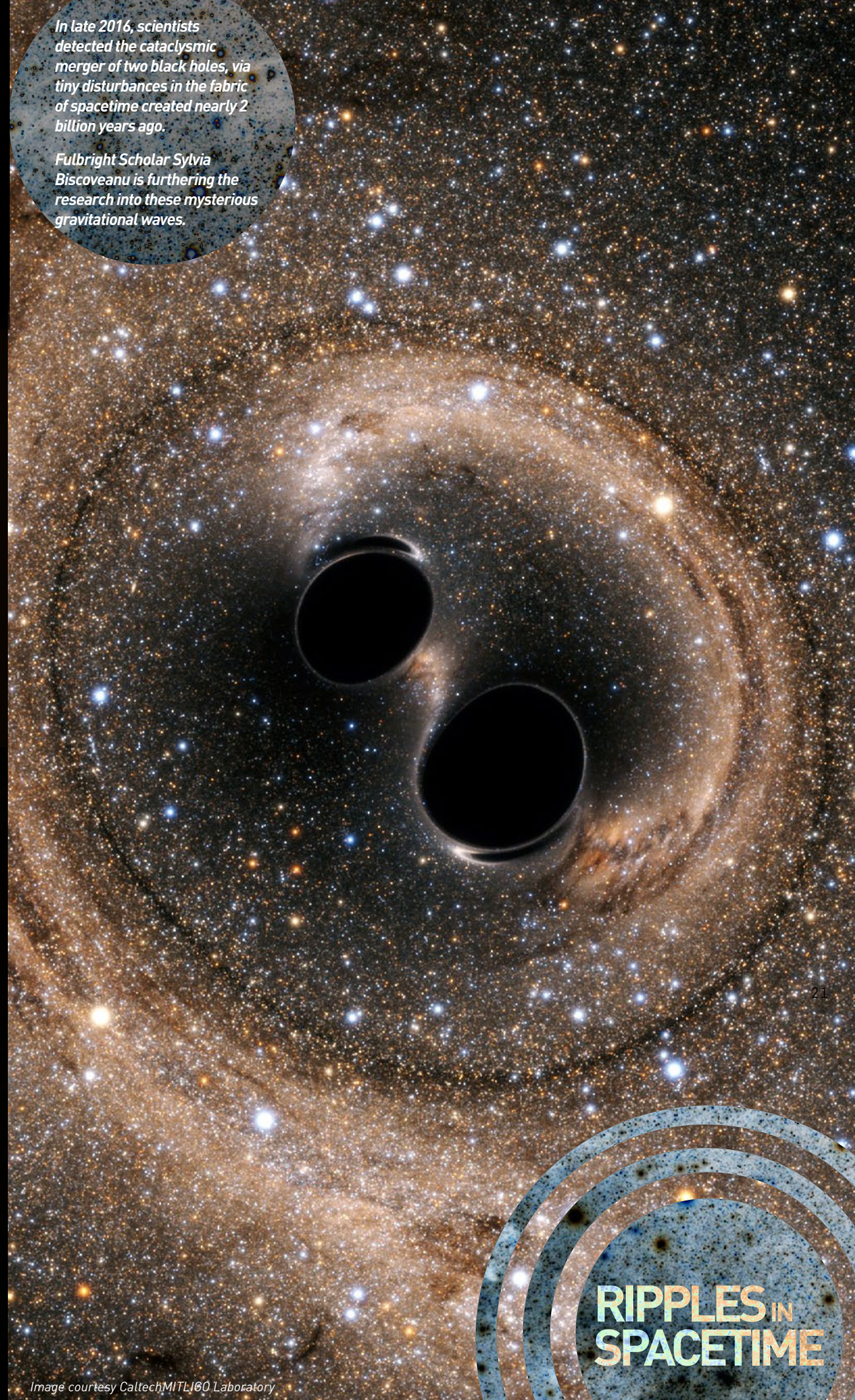
"The challenge of building an instrument capable of quantum computation depends on roughly five requirements.

"These include well-defined two-level quantum states, or qubits; reliable preparation of these bits in different states; low decoherence; accurate quantum gate operations; and a reliable method of accurately measuring stored information."

In other words, there are still some significant challenges ahead for Noah and Professor Morello's team at CQC2T before flip-flop qubit-based quantum computers can be commercialised. However their work is at the forefront of the field, and theirs is one the most promising breakthroughs in computing in decades.



Quantum chips are approximately 1.5mm x 1.5mm in size



In late 2016, scientists detected the cataclysmic merger of two black holes, via tiny disturbances in the fabric of spacetime created nearly 2 billion years ago.

Fulbright Scholar Sylvia Biscoveanu is furthering the research into these mysterious gravitational waves.

Image courtesy CaltechMITLIGO Laboratory

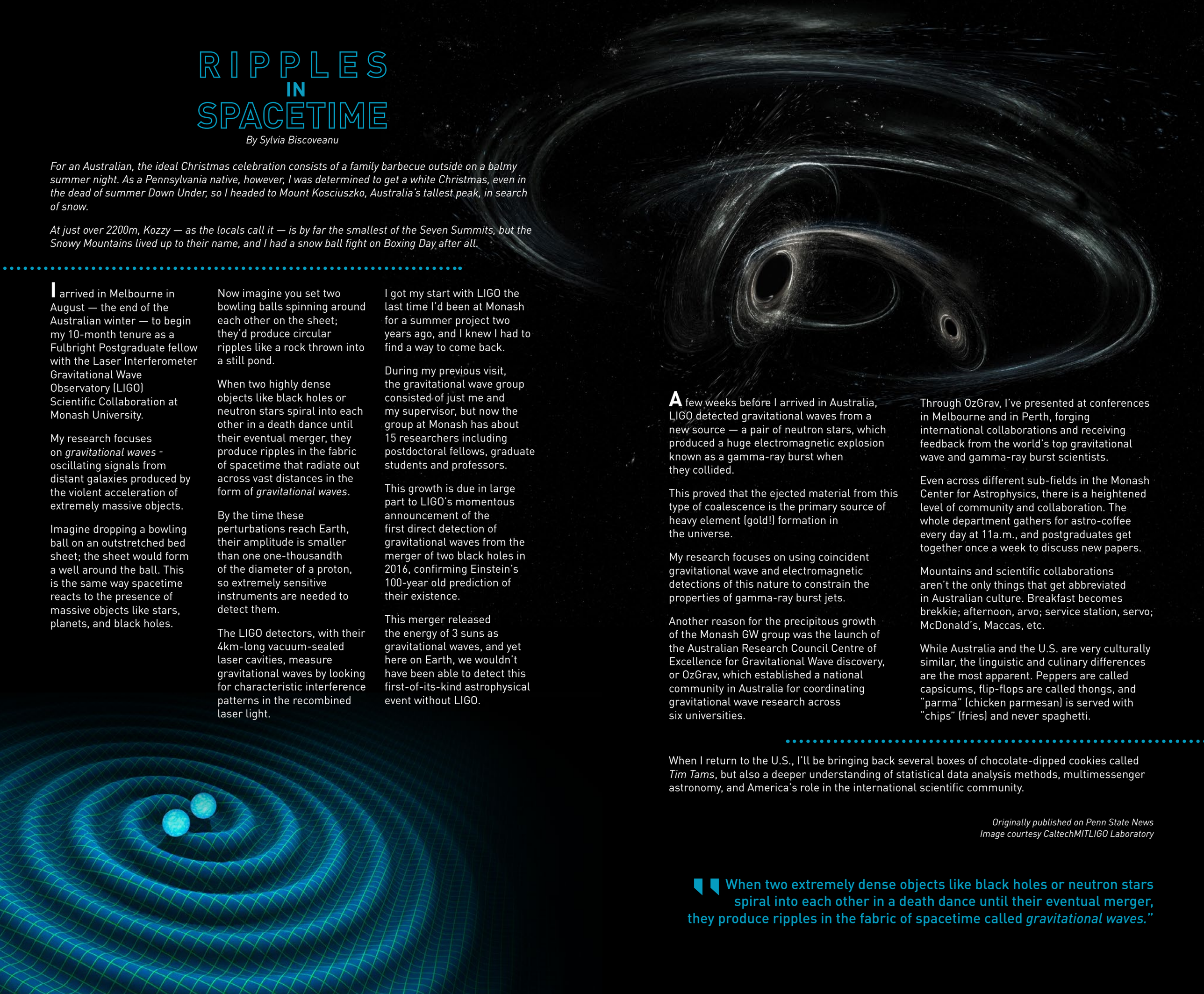
RIPPLES IN SPACETIME

RIPPLES IN SPACETIME

By Sylvia Biscoveanu

For an Australian, the ideal Christmas celebration consists of a family barbecue outside on a balmy summer night. As a Pennsylvania native, however, I was determined to get a white Christmas, even in the dead of summer Down Under, so I headed to Mount Kosciuszko, Australia's tallest peak, in search of snow.

At just over 2200m, Kozzy — as the locals call it — is by far the smallest of the Seven Summits, but the Snowy Mountains lived up to their name, and I had a snow ball fight on Boxing Day after all.



I arrived in Melbourne in August — the end of the Australian winter — to begin my 10-month tenure as a Fulbright Postgraduate fellow with the Laser Interferometer Gravitational Wave Observatory (LIGO) Scientific Collaboration at Monash University.

My research focuses on *gravitational waves* - oscillating signals from distant galaxies produced by the violent acceleration of extremely massive objects.

Imagine dropping a bowling ball on an outstretched bed sheet; the sheet would form a well around the ball. This is the same way spacetime reacts to the presence of massive objects like stars, planets, and black holes.

Now imagine you set two bowling balls spinning around each other on the sheet; they'd produce circular ripples like a rock thrown into a still pond.

When two highly dense objects like black holes or neutron stars spiral into each other in a death dance until their eventual merger, they produce ripples in the fabric of spacetime that radiate out across vast distances in the form of *gravitational waves*.

By the time these perturbations reach Earth, their amplitude is smaller than one one-thousandth of the diameter of a proton, so extremely sensitive instruments are needed to detect them.

The LIGO detectors, with their 4km-long vacuum-sealed laser cavities, measure gravitational waves by looking for characteristic interference patterns in the recombined laser light.

I got my start with LIGO the last time I'd been at Monash for a summer project two years ago, and I knew I had to find a way to come back.

During my previous visit, the gravitational wave group consisted of just me and my supervisor, but now the group at Monash has about 15 researchers including postdoctoral fellows, graduate students and professors.

This growth is due in large part to LIGO's momentous announcement of the first direct detection of gravitational waves from the merger of two black holes in 2016, confirming Einstein's 100-year old prediction of their existence.

This merger released the energy of 3 suns as gravitational waves, and yet here on Earth, we wouldn't have been able to detect this first-of-its-kind astrophysical event without LIGO.

A few weeks before I arrived in Australia, LIGO detected gravitational waves from a new source — a pair of neutron stars, which produced a huge electromagnetic explosion known as a gamma-ray burst when they collided.

This proved that the ejected material from this type of coalescence is the primary source of heavy element (gold!) formation in the universe.

My research focuses on using coincident gravitational wave and electromagnetic detections of this nature to constrain the properties of gamma-ray burst jets.

Another reason for the precipitous growth of the Monash GW group was the launch of the Australian Research Council Centre of Excellence for Gravitational Wave discovery, or OzGrav, which established a national community in Australia for coordinating gravitational wave research across six universities.

Through OzGrav, I've presented at conferences in Melbourne and in Perth, forging international collaborations and receiving feedback from the world's top gravitational wave and gamma-ray burst scientists.

Even across different sub-fields in the Monash Center for Astrophysics, there is a heightened level of community and collaboration. The whole department gathers for astro-coffee every day at 11a.m., and postgraduates get together once a week to discuss new papers.

Mountains and scientific collaborations aren't the only things that get abbreviated in Australian culture. Breakfast becomes brekkie; afternoon, arvo; service station, servo; McDonald's, Maccas, etc.

While Australia and the U.S. are very culturally similar, the linguistic and culinary differences are the most apparent. Peppers are called capsicums, flip-flops are called thongs, and "parma" (chicken parmesan) is served with "chips" (fries) and never spaghetti.

When I return to the U.S., I'll be bringing back several boxes of chocolate-dipped cookies called *Tim Tams*, but also a deeper understanding of statistical data analysis methods, multimessenger astronomy, and America's role in the international scientific community.

Originally published on Penn State News
Image courtesy CaltechMITLIGO Laboratory

> "When two extremely dense objects like black holes or neutron stars spiral into each other in a death dance until their eventual merger, they produce ripples in the fabric of spacetime called *gravitational waves*."

VIRTUAL WORLDS

By the Editor

The bell rings, ending today's face-to-face component and as your classmates log off, you see their digitally-rendered avatars fade one by one. *HoboBaggins99*, ever the class clown, floats one final poop emoji across the room before blinking out of existence in a cacophony of guffaws.
For the third time this week, you are touched by a strong suspicion that he is actually just an eight-year-old kid who has figured out the password to his big brother's PC.

You shrug off this thought as you remember that you need to talk with the tutor about next week's assignment – you're having motion sickness issues when attempting to traverse the procedurally-generated scale model of Sagittarius A via the school's virtual portal (a requirement for the practical VR component of this astrophysics class).

As you approach the front of the classroom, which today has been transposed onto the surface of an asteroid, you can't help but marvel at the dizzying array of computer-generated stars, planets and distant galaxies that appear to orbit this digital learning space.

The tutor notices your awe and laughs, her voice reverberating through your ears with stunning clarity;

"Virtual reality technology is pretty amazing, right?"

You would never guess that she is actually teaching this class from over 13,000 km away.

Image: Techstock

VIRTUAL REALITY's road to maturity has been, at best, a little rocky – what began as a far-fetched science fiction concept evolved over time to become far-fetched, nausea-inducing and impractical '90s video game technology.

Over the past decade however, VR has enjoyed something of a revival, as both software and hardware have finally begun to catch up with the photo-realistic requirements of true virtual immersion. While the entry barriers for most are still a little high, the first truly compelling consumer-priced VR hardware may be closer than you think.

Cutting-edge tech entrepreneurs like Fulbright Scholar James Riggall are leading the way in advocacy for the practical applications of VR technology. James, originally from Launceston, is currently teaching courses in 'Virtual Worlds' at Bellevue College in Seattle via the Fulbright Scholar-in-Residence program.

His classes examine both current and potential applications of virtual reality, and explore its history, tracing its evolution to the simmering pot of potential and opportunity that the technology now represents.

"The power of [virtual reality technology] is really amazing," he said.

"It gives you the ability to put your eyes and ears in a different space, as well as manipulate scale, contextualise information in the real world, or create 3D scale representations of complex systems.

"Most industries are, at the very least, beginning to explore these technologies in research and development.

"Architecture and engineering are among the industries starting to look at it seriously and use it quite heavily.

> "[VR] gives you the ability to put your eyes and ears in a different space; manipulate scale; contextualise information in the real world, or create 3D scale representations of complex systems."

"Microsoft and Google are also investing heavily into mixed and virtual reality devices, and Mark Zuckerburg said recently he wants a billion people using virtual reality by next year."

Bellevue College, situated in the tech hub of Seattle, was a natural fit for a guy who has been one of Launceston's most passionate voices for start-up technology, digital enterprise and STEM literacy. As well as founding his own technology consulting startup, Bitlink, James also co-developed Enterprize; an innovation hub that fosters other Tasmanian start-ups.

"I'm very much in my element over here," he said.

"People from Microsoft and Amazon and so on are a dime a dozen, so everyone is really technically literate. There's stuff I have to explain in Tassie, buthere you just assume they know it."

James is keeping his Australian connection strong, however, live-streaming his classes weekly to Enterprize's campuses in Launceston and Hobart, as well as RMIT University in Melbourne. He hopes to use his eight months in Seattle to build a foundation for future collaboration across the Pacific.

"A big question for me when I come back is – how can I make this opportunity more available to more people in Tasmania?" he said.

"We want people to have a global point of view, and I would also love to build a community ... between Tasmania and the Pacific Northwest. I think that can be done."

Images (from top): James teaches his first class in Virtual Worlds*; James' students at Bellevue College; James and his longtime mentor/collaborator Bruce Wolcott test a VR device*

While the hardware has come a long way, VR technology still has a few kinks to iron out before it is ready for everyday application. The current issues stem from a concept known as 'presence'.

Presence, in a nutshell, is the feeling of actually experiencing another reality when in VR. It differs from 'immersion' in that, rather than experiencing the projection of another reality, you feel as though you've truly, physically, stepped into a new dimension; like a suspension of disbelief for your senses.

Obviously this is a huge challenge for any developer - the human mind processes so much information at any given time that the slightest inconsistency, glitch, or drop in frame-rate will dispel the illusion.

Michael Abrash, from the virtual reality team at game developer, Valve is a strong believer in the power of presence, not only as an experience, but as a catalyst for transforming the entertainment industry.

"Presence is an incredibly powerful sensation, and it's unique to VR; there's no way to create it in any other medium." He said at a developer conference in 2014.

"Trying to describe it is bound to come up short – you can only really understand it by experiencing it. It's taking off the head-mounted display and being disoriented to find the real world there. It's more than just looking at someplace interesting; it's flipping the switch that makes you believe... that you are someplace interesting.

"Presence is one of the most powerful experiences you can have outside reality, precisely because it operates by engaging you along many of the same channels as reality. For many people, presence is simply magic.

"Once hardware that supports presence ships, we think it has the potential to cause a sea change in the entertainment industry. Not only could VR rapidly evolve into a major platform, but it could actually tip the balance of the entire industry from traditional media toward computer entertainment."

Abrash's team has identified eight specific technological barriers to simulating perfect presence: field of view, resolution, pixel persistence, refresh rate, global display, optics/optical calibration, tracking, and latency.

Field of View

Creating a 'borderless' visual experience is, of course, key to immersion, hence a wide field of view is crucial. FOV also provides peripheral visual cues that are critical for motion, balance, and situational awareness.

According to Abrash, presence begins to work somewhere around an 80° field of view, and improves significantly at least out to 110° in testing.

Pixel 'Persistence'

This is the length of time each pixel remains lit. It's not crucial for TVs, monitors, or mobile, but it's uniquely important for VR, due to the much faster motion of the eyes relative to the head-mounted display. This is especially true due to a low-level visual system called *VOR*, which allows the eyes to remain steady during rapid head motion. The longer pixels persist, the farther the pixel images smear across the retina when the eye is moving, and the blurrier the scene becomes.

Resolution

This is a particular issue with VR because the wide field of view spreads out and magnifies the pixels; the per-degree pixel density of a 1K x 1K, 110° VR display is roughly 1/7 that of a big-screen TV, and about 1/10 that of the eye itself. Valve's testing has put 1080p resolution as the baseline for presence - higher would be better, however appropriately-sized panels have yet to be developed.

Refresh Rate

This is a measure of how many frames a screen can display in a second. With traditional TVs, this was 60 times each second, or 60Hz. Given a wide field of view, once persistence is lowered, refresh rate has to increase; at 60 Hz, low persistence images flicker badly. In order to address this, Valve have built the fastest low-persistence headmounted display at 95 Hz, and that successfully eliminates visible flicker. VR quality suffers noticeably when image-rendering doesn't keep up with frame rate, and it will be a challenge to maintain 95 Hz stereo rendering, particularly as resolutions climb.

Global Display

A global display illuminates all pixels simultaneously, as opposed to the more standard rolling display, where pixels are illuminated in a scanned sequence over the course of a frame.

Global pixel illumination helps mitigate the compression, stretching, and tilting problems that can occur with traditional displays.

Latency

Latency, in this context, is essentially the lag before your movement or input is registered by the VR system. For VR presence to work, the virtual image must always be in the right place at the right time, which means that latency has to be as low as 20 *milliseconds*, as measured from the time head motion occurs to the time the last photon is emitted as a result of that motion. Beyond 25ms, the virtual world loses its sense of stability, and the human perceptual system is no longer convinced that it's looking at reality.

Optics/Optical Calibration

This is an exceedingly tricky one - human eyes are incredibly sensitive to deviations, and the calibration required for an immersive visual experience relies on a number of complex factors that can vary from person to person. In addition, optics must function in unison with all of the other elements mentioned here, be light enough to fit in a headset, and cheap enough to be commercially viable.

Tracking

Visual quality alone is not adequate for the creation of true presence. This must be combined with a system that tracks the position, movement and orientation of the head, and accurately translates into x, y, and z coordinates. There are several systems in development that use various technologies to achieve this, including placing scannable reference points around the room, however a more consumer-friendly system is still a little while away.

While we already have access to super high resolution displays and computers with enough processing power to address many of these issues, combining all of the required technology into a headset that's both small enough so as not to intrude on the experience and (importantly) cheap enough that it can be mass produced and within a reasonable price-point for the average consumer, is a huge challenge.

Not to mention the hardware must also be adaptable enough to fit a variety of head shapes and be calibrated for different eye-strengths, and that any headset must also be combined with both 3D audio and a haptic feedback controller that can adequately simulate corresponding movement and sound.

Beyond all of this, there must be talented software developers designing applications to harness the technology effectively, and while we've seen great strides with Playstation VR and Oculus Rift, there is still a great deal of room for improvement before that all-important sense of presence can be attained.

Yet it is now within our grasp; once the first consumer-priced VR presence has been shipped, the potential is near limitless: hands-on, lifelike education simulations for pilots, astronauts, and medical students; photorealistic face-to-face social engagement with friends on the opposite side of the planet; 3D renderings of future real-estate developments that buyers can actually walk through and experience years before construction; even therapeutic programs to treat depression, PTSD or physical impairment.

Little wonder that Michael Abrash describes the technology as "simply magic".

Thanks to developers like his team at Valve, and technology educators like James Riggall, this magic could be teleporting you from your living room within the next couple of years.

James Riggall

FLORIDA: A Biologist's Cornucopia

Jenna Crowe-Riddell

My research is focused on the evolution of senses in sea snakes.

I'm a researcher at the University of Adelaide, and my Fulbright scholarship was spent at University of Florida (UF) in Gainesville, Florida.

For a biologist, Florida is one of the most interesting places to visit. It's a subtropical paradise filled with marvellous animals and, well, interesting Floridians!

Despite the density of people, (in a state about the size of Victoria they fit in 18 million people - just shy of Australia's *total* population of 22 million), Florida harbours a dense population of unique animals. Coming from Australia, I was thrilled to see even the most 'run-of-the mill' animals like squirrels, woodpeckers and red cardinal birds.

At night, I could hear the rustling of opossums. During the day anole lizards scurried underfoot, and the waterways of the UF campus are riddled with alligators!

What's most apparent about Floridian ecosystems is that they are swamped with non-native animals, including Burmese pythons from Asia, curly tail lizards from the Carribean, and chameleons from Africa.

The University of Florida has a strong research basis in Biology and Herpetology (amphibians and reptiles) and I was lucky enough to participate in fieldwork while there.

In Florida, I helped catch invasive anole lizards using a fishing pole with a tiny noose tied to the end, and was lucky enough to travel to Costa Rica to research the yellow-bellied sea snake.

But my fondest experience was a trip to a Florida island to catch cottonmouth snakes, which are highly venomous but generally placid on islands.

The snakes scavange fish that are dropped by birds overhead. You'd think that these snakes rarely get a feed, but during the nesting season the trees are teeming with birds and the snakes just wait patiently underneath.

While we were walking along, a pelican dropped a kilo of half-digested fish on my head. It was one of the most bizarre experiences of my life, but also the happiest I've ever been to be shat on by a bird...

Image Key:

1. A yellow bellied sea snake flits through the water.

2. I travelled to Costa Rica on field work to catch yellow bellied sea snakes. They are deadly venomous but relatively placid animals.

3. Anoles lizards! The invasive brown anoles scurry underfoot, more numerous than ants in Gainesville! I spent much of my time in UF at a lab that studies Anole developmental biology. To catch an anole you need a fishing pole, dental floss and patience.

4. Manatees are winter visitors to many of the natural waterways in Florida. When the Gulf of Mexico becomes too cold, they travel inland to the relatively warmer freshwater springs.

5. Venomous island-dwelling cottonmouths have a unique relationship with nesting birds: they scavenge fallen fish and the occasional baby bird that is unlucky enough to fall from its nest.

6. Boat-tailed grackels are common birds in Florida. Their quiet intelligence reminded me of Australian magpies.

7. Not a sea snake! This diamondback terrapin is rare, as it is one of the only (non-sea turtle) reptiles that can live in high saltwater environments. I participated in local UF surveys to monitor this unique population, and was rewarded with the discovery of a baby turtle nestled amongst the mangrove shoots on the beach.

CATCH ME WHEN I FALL

By the Editor

According to the World Health Organisation, falls are the second leading cause of accidental or unintentional injury deaths worldwide, second only to traffic incidents. An estimated 646,000 individuals die from falls each year, with the elderly and motor-impaired at most risk.

Even if a fall isn't fatal, approximately 37 million such incidents annually are serious enough to require hospitalization, pushing global public health costs into the billions.

Education, training, and the creation of safer environments are all proven strategies to help mitigate the risks of injury and death, but what if technology could step in and provide new solutions to prevent fall-related fatalities?

Fulbright Scholar Michael Raitor's research into biomechanics and haptic feedback technology could represent the greatest breakthrough in fall-prevention since the invention of the handrail. He is currently in Australia, capturing data on walking and movement patterns for clinical detection of abnormality, as well as potential use in 'wearable' fall prevention devices.

"What we've learned so far from fall research is that we can model falls that we've observed in labs pretty well, but we know that falls simulated in a lab environment don't accurately represent falls that occur in real-life situations.

So one of the areas of research that I'm interested in is gathering real-world information on 'gait' that we can use to identify abnormal patterns that may increase fall risk, and mitigate these risks through intervention, whether that be via physical therapy or an assistive device. Additionally, if a fall does occur while wearing the system, we could alert caretakers or first responders of the fall so the user gets help as soon as possible.

"We are also looking into targeting specific types of falls. There are many different causes for falls – you can fall by misstepping, tripping, or simply leaning too far to one side– and each may require a different approach to solve."

Michael is particularly interested in a promising new technology developed by Associate Professor Stephen Redmond at the University of New South Wales' Biomedical Systems Laboratory.

"[A/Prof Redmond] is working on a 'slip sensor' that can determine how likely something is to slip. I'm looking at adapting this research into a shoe that can detect when someone wearing it is about to slip, and intervene in one of two ways: one would be subconscious, by actually augmenting their perceptual abilities, and the second would be a conscious vibration, through a cellphone or smartwatch.

"With the conscious approach, the implementation of a haptic feedback system would be less complex, however it's not ideal – while the physical vibration may be useful to notify the wearer that they are about to fall, the distraction caused by this sudden sensation may in fact *cause* them to fall.

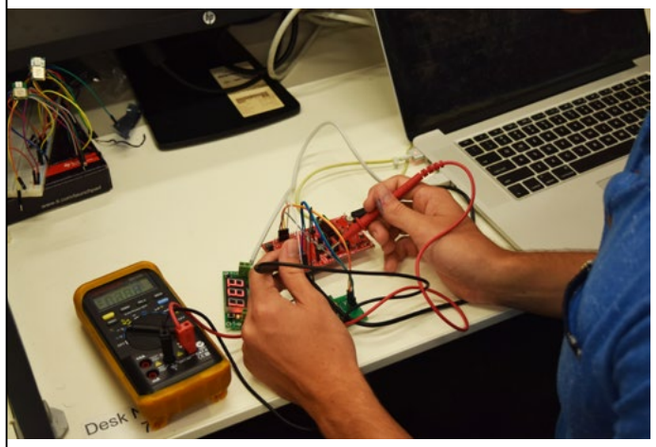
"The subconscious approach would involve stimulating the foot in such a way that the wearer would be better able to instinctively detect if they are about to slip, effectively augmenting their natural ability to prevent a fall from occurring."

Scientia Professor Nigel Lovell, co-director of the Biomedical Systems Laboratory, has valued Michael's contribution to their work.

"Michael has been an outstanding addition to our research group at UNSW.

"We are researching how to better characterise gait and movement. Using such measures we will be able to design wearable devices that interpret movements and, for example, automatically raise an alarm when a frail older person has fallen and failed to rise.

"Michael has contributed greatly to the analytic approaches and algorithms for this movement characterisation. He has embraced the Australian culture and is a superb ambassador for the Fulbright Program."



Images (from left): Michael with his research poster at the 2018 Fulbright Gala Presentation Dinner; (Overleaf) Michael soldering the electronic circuit that powers his concept device; Michael's device in testing; Michael researches natural walking patterns and gait to create algorithms that can calculate fall probability

One of the most incredible things about Michael's story is that he has accomplished all of this research despite having a vision impairment of his own - Stargardt disease, a degenerative retinal condition symptomatically similar to macular degeneration.

This hasn't held Michael back, however, and in fact has been one of his motivations for ensuring that new fall prevention technology is effective, and accessible.

"One thing that I've come across often, especially if I'm walking home in the dark, is that a lot of times I'll stumble or catch myself just because of the lack of visual acuity, or uneven pavement.

"Through experiences such as this, it very quickly became apparent to me that in situations where you don't have the visual cues you're used to, falling becomes much more of a problem and you rely on other resources such as a relatively strong sense of balance in my case.

"The underlying causes of falls can vary widely among users and it's important to create a robust solution that can be used to help as many patient populations as possible.

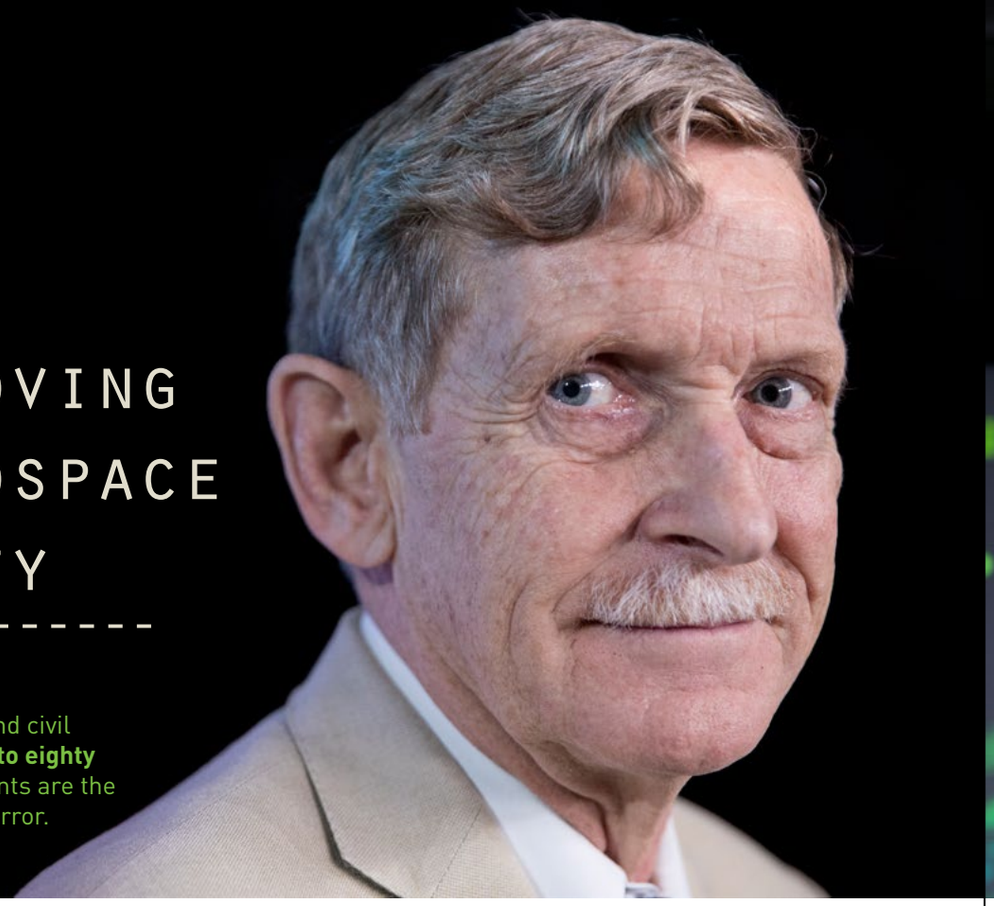
"The realisation that falls aren't isolated to the elderly, motor impaired, or distracted Twitter users was definitely a motivating factor to my current work. "

Until new technology is commercialised, falls will continue to be a serious public health risk, however thanks to the work of researchers such as Michael and Prof. Lovell's team at UNSW, the testing and perfecting of these devices, as well as our understanding of human movement, will continue to improve in leaps and bounds.

Improving Aersospace Safety

Dr Angus Rupert

In both military and civil aviation, **seventy to eighty percent of** accidents are the result of human error.



A leading cause of aviation mishap fatalities is spatial disorientation which is frequently related to degraded visual environments (DVE) including night flight, fog, snow, rain, and now, sand obscuration in desert operations. In recent desert conflicts, Australia and coalition partners have experienced loss of aircraft due to DVE.

When pilots are deprived of visual features outside the aircraft during DVE, in order to maintain orientation, they must transition to their cockpit instruments and perform a scan of several instruments including the pitch and roll attitude indicator, altitude instrument, heading indicator, vertical velocity indicator, airspeed indicator, and many other instruments regarding aircraft performance and geographic location.

Pilots are taught to perform a rapid scan of the instruments which must be repeated every few seconds in order to avoid becoming disoriented, especially during dynamic conditions of flight.

When flying manually, only a few seconds of distraction may result in the aircraft inadvertently assuming a position from which it is difficult or impossible to recover.

The Tactile Situation Awareness System (TSAS) developed by Fulbright Scholar, Dr. Angus Rupert, provides situation awareness information to pilots through the sense of touch.

It presents information, including aircraft position, attitude, altitude, acceleration and velocity through the use of tactile stimulators distributed on the torso. The potential safety benefits of TSAS include reduced spatial disorientation mishaps; improved situational awareness; improved pilot control; and reduced pilot workload during critical flight maneuvers such as hovering in zero visibility, flight transitions, approach and landing.

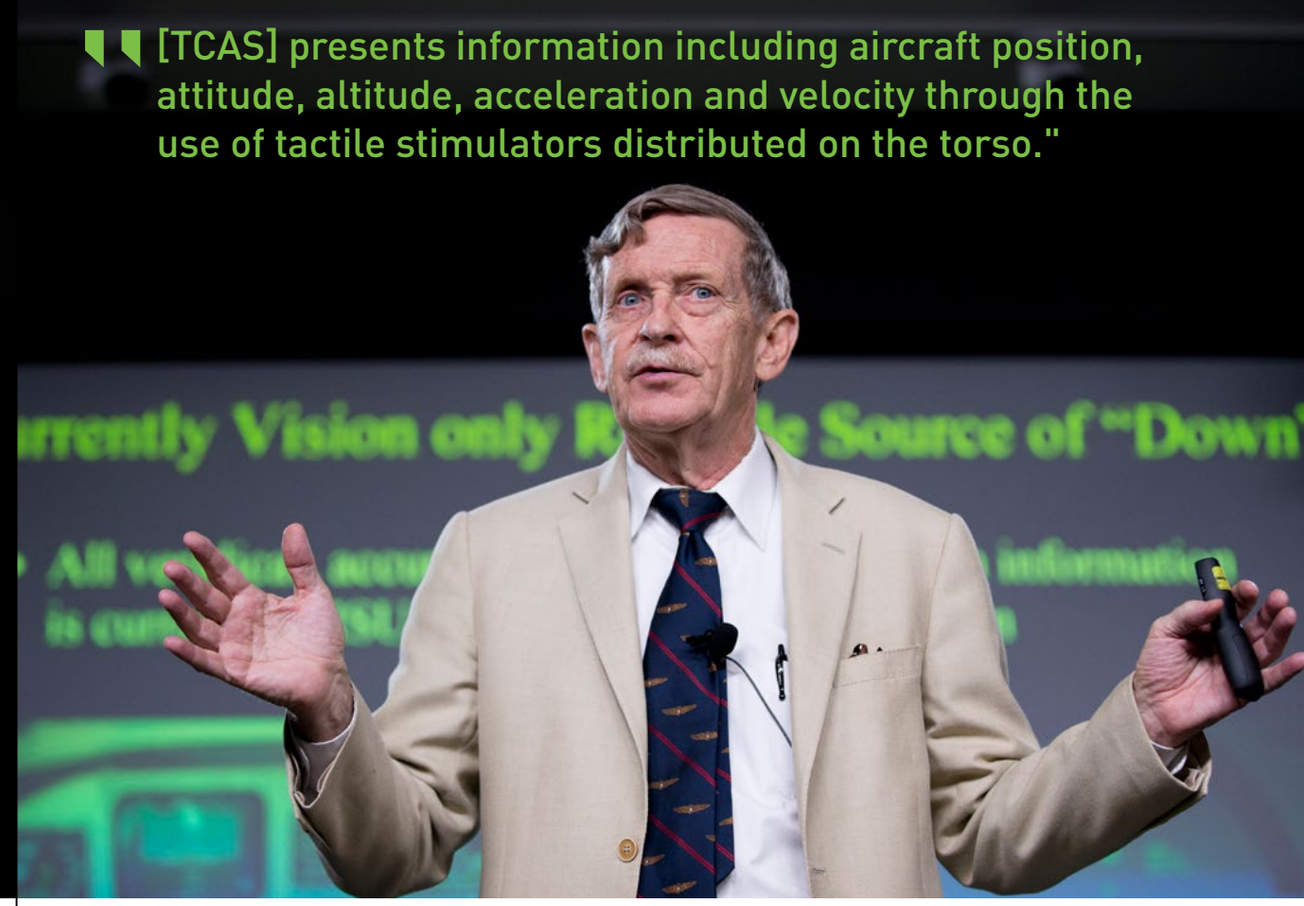
TSAS reduces pilot workload, increases situational awareness and mission effectiveness allowing pilots to devote more time to other tasks requiring visual attention.

CH-47F Chinook helicopter

The Australian government awarded a Capability and Technology Demonstrator (CTD) to University of Canberra and the Defence Science & Technology Group (DST Group), Fishermans Bend to demonstrate the Tactile Cueing System (TCS) in the new CH-47F Chinook helicopter.

The Australian-American Fulbright Commission provided the opportunity for Dr. Rupert to collaborate with DST Group, the Australian Army and University of Canberra to develop the Australian Tactile Cueing System.

> "[TCAS] presents information including aircraft position, attitude, altitude, acceleration and velocity through the use of tactile stimulators distributed on the torso."



What sets the Australian TCS apart from TSAS are many novel advances including the incorporation of recently-developed piezoceramic tactile stimulators (tactors) into a T-shirt garment and the use of Bluetooth to communicate information from aircraft sensors.

The August flight demonstrations compared the use of traditional belts versus T-shirts and also the ability of aircrew gunners to use tactile cueing for localization of targets.

In addition to the aviation applications, a ground demonstration for land navigation was conducted using tactile cueing to provide intuitive, non-visual navigation guidance to soldiers.

Demonstrations to various department of defence components (land, maritime and ground) have resulted in ongoing and continuing collaborative efforts to bring tactile cueing into the Australian defence communities in cooperation with industry and universities.

Dr Angus Rupert | 2016 Distinguished Chair in Advanced (Defence) Science & Technology | U.S. Army Aeromedical Research Laboratory > Defence Science and Technology Group, Aerospace Division

Dr Rupert gained his PhD in Neurophysiology from the University of Illinois in 1979 and then pursued his MD degree at the University of Toronto in his native country Canada, finishing in 1982. Dr Rupert developed, based on psychophysics experiments, techniques to conduct perceptual analysis of aviation spatial disorientation mishaps for the U.S. National Transportation Safety Board and other nations, including Australia. To maintain pilot orientation continuously and prevent spatial disorientation mishaps, Dr Rupert developed the concept of tactile cueing as a tool for pilots and as a prosthesis device for patients with balance dysfunction.

For the past 20 years, Dr Rupert has refined tactile cueing and integrated 3D auditory and traditional visual displays with tactile cues to create multisensory cueing for pilots. Due to his flight tests and tactile cueing demonstrations in the United States and Canada, the Australian MOD has recently selected Dr Rupert's tactile cueing technology as one of five key technologies for the Capability and Technology Demonstrator program.

Angus worked with the Australian Department of Defence, and the Defence Science & Technology Group in Melbourne to introduce and integrate tactile cueing onto helicopter platforms and ground soldiers in order to demonstrate the additional capabilities provided to pilots and soldiers. He also provided versions of tactile cueing to the civil aviation community as well as demonstrations of tactile cueing as a prosthesis device for balance impaired patients. Lastly Dr Rupert gave lectures and examples of perceptual analysis of aviation mishap investigation to the ATSB (Australian Transport Safety Bureau).

The Importance of STRUCTURE In Learning Spaces

Raechel French

During my year as a Fulbright Postgraduate Scholar, I researched alongside a PhD cohort on a study entitled Innovative Learning Environments and Teacher Change (ILETC).

It was a unique opportunity to pursue my own research question while aligning with a larger group studying a very similar context and issue. In fact, the alignment was so strong that I am now an official PhD Candidate with the ILETC and can formally continue my research through this program.

Many primary and secondary schools embark on a building project with the expectation that a change in space will naturally result in a change in pedagogy. However, in my four years working in architectural practice as an Educational Planner, this expectation too often falls flat.

What often results instead is that a school may enjoy all the attributes of a 21st century learning environment but in reality, continues to house a single-cell, industrial pedagogy.

My goal for my Fulbright year was to explore how to better manage this transition and identify the key characteristics designers, educators, and school leaders can utilize to turn their initial vision of student-centered, multi-modal, and engaging learning into reality.

Australia was the ideal location in which to explore this due to two key factors.

1. The University of Melbourne is home to the Learning Environments Applied Research Network (LEaRN) which arguably consists of the top researchers in the field of learning environment design and use; and,

2. the influx of new school infrastructure following the Building the Education Revolution program created a critical mass of schools struggling through the transition from traditional to innovative spaces.

Images (from top): Raechel presents at the Inveresk Design Forum at the University of Tasmania, invited and coordinated by fellow Fulbright scholar James Riggall; Raechel presents at the Transitions17 research symposium in Michigan, hosted by the ILETC; Mount Amos/Wineglass Bay, Tasmania; (overleaf) Raechel with baby kangaroo, Milly, while visiting the Alice Springs Kangaroo Sanctuary; Raechel accepts her Fulbright certificate from Chief Defence Scientist, Dr Alex Zelinsky

One trend constant in all case studies was the importance of structure.

Structure comes in many forms and across multiple layers of the school organization but represents the tactical level of the initial vision that underpins the design of the learning space.

Identified by one school leader as "restocking the toolkit", these structures are needed in the face of a reality in which educators will seek the familiar.

When a classroom is taken away, the purpose and potential of the open learning space that may have replaced it must be communicated with clarity and agreed standards of use identified.

When students no longer have to sit at a desk in a chair, facing the teaching wall, we should provide them a new set of behavioral expectations.

It all comes down to the proper induction of teachers and students to create the new normal in the learning experience.

I am currently drafting a paper unpacking this transition process further, identifying actionable tools for school designers, school leaders, and teachers.

These case studies will further serve as a pilot for my PhD research, exploring how these concepts translate into the U.S. context.

Raechel French | 2016 U.S. Postgraduate |
Cornell University > The University of Melbourne

Raechel has spent the past several years as an educational planner at DLR Group; an architecture firm in Austin, Texas helping plan and design schools across the United States. She earned a B.E.D. in Architecture and a B.S. in Psychology from Texas A&M University and a Master's in Human-Environment Relations from Cornell University, focusing on Facility Planning and Management with a minor in Organizational Behavior. In addition to her role as Educational Planner, Raechel helps lead her firm's K-12 research initiatives.

Many schools desire innovation and turn to their facilities as catalysts for change. However, there is often a disconnect between the vision of a facility and its subsequent use.

Recent shifts in Australian education policy and economic priorities have resulted in an influx of innovative learning environments that subsequently require new methods of teaching and the gap between design and use is apparent.

While in Melbourne, Raechel worked on the Innovative Learning Environments and Teacher Change (ILETC) project to identify relationships between quality teaching and the effective use of these innovative spaces. The goal is to help bridge the gap by developing a mechanism to change teacher mind frames and teaching practices.

Leadership: A Lesson in *Unlearning*

Professor Jean Lau Chin

Upon my arrival to the University of Sydney campus, I was pleasantly greeted with the huge slogan: *Leadership for Good Starts Here—A Lesson in Unlearning.*

Since my research as a Fulbright Scholar Distinguished Chair is about Global and Diverse Leadership, I thought this is how we should be talking about leadership. Good Leadership for Change is what we need in today's VUCA world – that is Volatile, Unstable, Complex and Ambiguous.

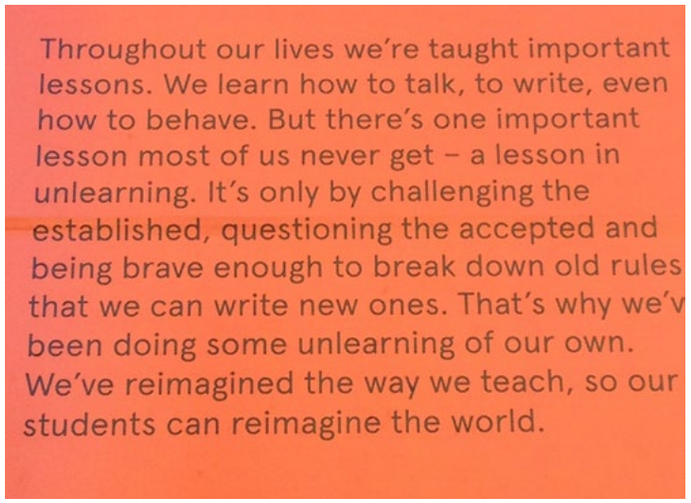
As our world becomes increasingly global and diverse, Leadership for Good is Leadership for Change to ensure that we improve lives and create a future for all humankind.

However, this will take some unlearning as we hold to truths that may not be inclusive of all perspectives.

"It's only by challenging the established, questioning the accepted and being brave enough to break down old rules that we can write new ones"—*Unlearning*.

As I examine prevailing paradigms of leadership, they may need to be unlearned because they are generally not inclusive of all perspectives. Rather, they reflect paradigms of the leadership of dominant groups in societies—typically that of white, North American men.

But unlearning is not simply about throwing out the old to bring in the new. Rather it is about looking at our past to see our future, and crafting a future that is sustainable, humane, socially just. It is a future that promotes the well-being of all peoples. Leadership for Change is the pathway for Leadership for Good.



As a Fulbright Scholar, I resonate with the Program's goals to increase cultural understanding, collaboration, and promote the exchange of ideas to share our best minds to improve lives.

As Senator Fulbright said:

"Our future is not in our stars, but in our own minds and hearts. Creative leadership and liberal education go together and are the first requirements for a hopeful future for humankind."

This thinking is as relevant today as it was when the Fulbright program began after WWII and we traded "swords for ploughshares" in transitioning from war to peace.

What is global and diverse leadership? My research at the National Centre for Cultural Competence at the University of Sydney is to expand our paradigms of leadership.

This means to include the perspectives of diverse leaders (i.e., their vision and leadership styles), to understand how leaders and followers interact with their diverse social identities and lived experiences, and to factor in the social and organizational contexts in which leadership occurs. All work together to create good leadership—Leadership for Change.

Yet, current leadership paradigms often presume there is a prototypic leadership style or a single set of leadership traits that make for good leaders based on those already in leadership roles or from dominant groups in society.

My research examines the leadership of diverse leaders in order to identify dimensions not currently included in current paradigms of leadership. Based on my previous work, we have found that ways of leading among minority, indigenous, and marginalized groups, i.e., ethnic minority, women, LGBT, indigenous groups, etc. are often viewed as less effective or weak.

These groups often experience negative bias about their leadership associated with stereotypic views about their social group, and challenges to their leadership based on gender or ethnicity.

We have found that "difference makes a difference" and that their experiences of leadership often differ from those from dominant majority groups.

At the National Centre for Cultural Competence, my research is to include the voices and narratives of Aboriginal and Torres Strait Islander leaders by collecting leadership interviews to capture the essence of their leadership, and how their leadership is influenced by their social identities, lived experiences, and social and organizational contexts.

I also administer a Leadership Dimensions Survey that does not start from a normative framework of existing leadership dimensions because that will privilege the knowledges and paradigms currently dominant in the leadership literature.

To be culturally competent, a principle aligned with the work and objectives of the National Centre for Cultural Competence, it is inductive rather than deductive. The result is evolving a framework that uses a strength based approach and affirmative paradigm of leadership.

We look to identifying successful and effective leadership practices that consider the importance of how cultural values influence leadership styles, and the need for leaders to adapt their styles to the prevailing context or composition of their members while remaining authentic.

Already, we are finding new strategies of leadership. The concepts of "leading from behind" or "the invisible leader" endorsed by Native American leaders is almost antithetical to Western ways of leading.

The emphasis on collaborative, collective and inclusive leadership common among many minority, Eastern, and indigenous groups contrasts with competitive, authoritative, and independent forms of leadership prominent in the literature.

Dr Chin with U.S. Charge d'Affaires, Mr James Carouso

Cooperative and non-confrontational approaches can and have been successful in a 21st century environment of rapid change, globalization, and growing diversity, and non-Western countries and groups increasingly become recognized as global leaders.

Why am I doing this research on Global and Diverse Leadership?

Jeffrey Bleich, in his keynote address at the Fulbright Orientation Gala at Canberra to welcome the 2018 Australian and American Fulbright Scholars said it well.

It is about "Technology, Truth, and Trust", core elements of Fulbright Scholar Program, and necessary principles to prevent war and intolerance, and to serve human needs. As I heard him speak, I see it as being about leadership—Leadership for Good, Leadership for Change.

The pressing issues of violence, immigration, climate change, sexual assault, and health care throughout the world impacts us all. We have witnessed within the United States an assault on truth; the propaganda about fake news has created doubt amongst us about what the facts are.

"We look to identifying successful and effective leadership practices that consider the importance of how cultural values influence leadership styles."

"We have seen the creation of conflict and the surfacing of deep divisions amongst us that have eroded our trust, and violated our core values about truth, equity, and social justice.

We are looking for change."

We have seen the use of technology for bad in the interception of information to do harm. We have seen the creation of conflict and the surfacing of deep divisions amongst us that has eroded our trust, and violated our core values about truth, equity, and social justice. We are looking for change.

But before that can happen, we need to take the bold step to *Unlearn*. We need to allow for the possibility that what we thought were permanent truths needs to be unlearned. We need to harness our technology to seek the truth and for good. We must build it based on trust—to be transparent, to collaborate for mutual interests and the greater good.

To what end? I see using the results of my research on Global and Diverse Leadership to develop a paradigm to promote Leadership for Good and Leadership for Change – one that is sustainable, to serve humanity with humility, one that is equitable to achieve social justice goals, and to improve the lives and well-being of all peoples.

Most of all, it is my hope that this research will enable us to identify diverse leadership role models, and to result in leadership development for diverse ethnic minority, women and indigenous groups that is culturally competent and enables them to lead effectively while remaining connected to their communities and authentic to themselves.

Professor Jean Lau Chin | 2017 Distinguished Chair in Cultural Competence | Adelphi University > The University of Sydney

Dr Chin is Professor at Adelphi University. Her career as a psychologist includes leadership roles in academia as Dean at Adelphi University and Alliant International University, and in health/mental health care as Executive Director at South Cove Community Health Center, and the Thom Clinic.

She is the past-Chair of the Council Leadership Team and has served on the Board of Directors of the American Psychological Association. She is also President, International Council of Psychologists. Her scholarship on diversity, cultural competence, leadership, Asian American, and women's issues includes 18 books and numerous publications and talks.

Her research will examine leadership and cultural competence amidst rapid social change and growing population diversity. She sees this as more important than ever as the 21st century brings about rapid social change within an increasingly global and diverse society. She will also work on leadership development for indigenous Aboriginal and Torres Strait Islander women in Australia.

China's State-Backed Start-up Push

Can the government create a true start-up ecosystem, or are its efforts only creating a bubble?

By Arjun Bisen

As China's manufacturing sector slows, the Chinese government has turned to the high-tech and start-up sectors to drive economic growth and employment. China's Internet Plus, artificial intelligence, and Made in China 2025 strategies aim to position China as the next technological powerhouse.

To achieve this vision, President Xi Jinping has said the Chinese government will actively support tech companies and first-class research. In particular, he emphasized the need to support small-to-medium enterprises and start-ups.

But it remains to be seen whether China's state-backed ecosystem is able to truly lead the world and spread innovation outside of elite firms to boost employment. To achieve its ambitions, it will have to earn the trust and respect of a broader audience; no small feat given the extent of state involvement.

For now, the approach seems to be spurring growth as intended. The *South China Morning Post,* citing a study by the Chinese Academy of Social Sciences, reported that the "new economy sector" counted as nearly 15 percent of the whole economy in 2016, with an annual growth rate of 16 percent in the 2007-2016 period. Tech giants Alibaba and Tencent alone are now worth more than a trillion dollars combined, thanks to their online payment networks and shopping platforms.

China is also responsible for some cutting-edge research and innovation, particularly in Zhangjiang Hi-Tech Park in Shanghai.

The Nature of State Involvement

China's underdeveloped capital markets and tightening real estate sector mean there is no shortage of funds looking for higher returns in the start-ups sector. But compared with other major economies, the state plays a much more prominent role. In Xi's own words, China's "biggest advantage is that we, as a socialist country, can pool resources in a major mission."

Governments have always played an active role in facilitating innovation, partnering with the private sector, and using the tech sector to further their own ambitions – but China places the state near the center of the ecosystem.

At least some element of the Chinese state, whether federal, provincial, or political, is involved in almost every facet of the tech ecosystem. The state is often the primary funder or at least a significant shareholder in start-ups. It also provides housing, office space, and salaries for many start-ups, and subsidies for major tech firms based in special economic zones.

During a recent visit to China, several founders and executives told me government relations are the most important factor for their business. Government cooperation was even an official pillar of activity within one incubator in Shanghai.

Many tech companies are also plugged into key national priorities and initiatives. Top-tier Chinese tech firms are working directly with the government on artificial intelligence projects, following Beijing's 2017 announcement of an ambitious agenda to "lead the world" in A.I. by 2030. Edutech firms provide training for foreign workers employed in Belt and Road projects. And advanced manufacturing firms that develop consumer goods also build military hardware for the People's Liberation Army.

Limitations of China's Model

While China's model, with its abundant capital, clear policies, subsidies, and government support, has undoubtedly helped create an impressive industry, it comes with some downsides. Beyond the shiny exterior are signs the ecosystem is not as healthy as it first appears.

The government's top-down, supply-driven approach may have led to a start-up bubble. City and provincial governments appear to have interpreted Xi's calls for greater support for small-to-medium start-ups to mean "build more incubators." The three incubators and special economic zone I recently visited were ghost towns.

Each of the incubators looked similar and had many of the same set of companies listed as clients, but few seemed to be in active use, suggesting a shortage in demand.

Outside of top-tier firms, reverse-engineering remains the dominant business model. The majority of businesses appeared to be co-opting existing foreign tech. This casts doubt on whether China's model for innovation can succeed at its second objective of creating new jobs en masse.

Global Leadership Requires Greater Trust

Questions also remain over whether China can marshal enough soft power to succeed in its goal of becoming a world leader in technology. The extent of state involvement, even when benevolent, does little to ease existing skepticism of Chinese tech companies and fear of Chinese economic coercion internationally. Recent allegations of spying on the African Union and threats of economic consequences for those who criticize Chinese foreign policy could further reduce trust in Chinese firms and limit their ability to expand globally.

The broader debates around ethics and societal impacts also appear significantly underdeveloped in China, despite Jack Ma's bold statements on the dangers of artificial intelligence at Davos. Questions about job losses due to advanced manufacturing are often dismissed by citing China's aging population, and discussions about privacy, ethics, and the impact of advanced state surveillance are shrugged off.

To be seen as a global leader in technology, Chinese industry needs to build trust abroad. To do so, the state would need to draw clearer lines between its interests and tech firms. Chinese industry would also need to engage more frankly in global debates on technology and society. A focus on technological growth has sufficed until now, but to realize China's broader ambitions, there needs to be a shift.

Originally published in The Diplomat

Arjun Bisen | 2017 Fulbright Anne Wexler Scholar in Public Policy | University of Technology Sydney › Harvard University

Arjun used his Fulbright-Anne Wexler Scholarship to undertake a Masters in Public Policy at Harvard Kennedy School, researching China's relationship with weak states, and its impact on security in the Indo-Pacific region. He also explored the opportunities presented by emerging technologies and advances in behavioural sciences to improve the implementation of foreign policy and deliver development outcomes.

Image: Vexels.com

Obituary - Dr Adele Millerd; Australia's First Fulbright Scientist

Alison "Adele" Millerd was a gifted scientist. She was born in Sydney on October 21, 1921, and died at the age of 96 in Sydney on December 3, 2017. She led an extraordinarily productive and interesting life.

Her parents were school teachers and the family moved from Sydney to Tocumwal, Bellingen and Cessnock. Millerd therefore had a peripatetic education, mostly attending the schools where her father taught, not an experience she particularly relished. She repeated year 12 because she couldn't decide what to do next. She had never been asked what she wanted to do with her life; she didn't know what to say!

She won an exhibition to the University of Sydney in 1940 and lived at Women's College for the three years of her degree, studying her passion, chemistry. Her parents' guidance through her education resulted in her being able to offer tuition to other women at the college who had not studied science at school.

While she studied for her degree, she had a summer job at the Riverstone Meatworks and also worked there full time after she graduated.

She didn't enjoy the job so she moved to a private pathology practice in Macquarie Street, where she was responsible for the practice's biochemistry.

In 1945, the University of Sydney was inundated by returned soldiers completing their education and Millerd joined the biochemistry department as a teaching fellow offering courses to medical and dental students. She enrolled in a masters degree, choosing plant biochemistry as her research topic.

While studying for her masters, she lectured in that subject. She obtained a Linnean Macleay fellowship, which allowed her to focus on her research.

After completing her masters, she enrolled in a PhD. A visit to the university by Dr James Bonner, ofthe Californian Institute of Technology, put her in touch with similar work he was doing in Caltech's biology department.

She applied for and was awarded a Fulbright scholarship to study in the United States. Millerd was one of the two first female students, and the first scientist, to receive this scholarship.

She returned from the U..S in 1953 and was appointed senior lecturer in the University of Sydney's biochemistry department. After study leave at the McCollum Pratt Institute at Johns Hopkins University in Baltimore in 1959, she returned to Australia to an appointment at the Waite Institute in South Australia in agricultural chemistry.

That appointment was followed by a new appointment in 1963 to the genetics section of CSIRO's division of plant industry as a molecular biologist and biochemist. She later transferred to the plant physiology section.

> "Millerd learned to speak Spanish fluently and travelled widely in South America. She also became an expert in computing."

Millerd had two sabbatical leave experiences during this time, one at the University of California San Diego in La Jolla. There, she became interested in the accumulation of storage proteins in legume seeds. On returning to Canberra, she was invited to join a multidisciplinary group to use her knowledge to explore the molecular biology of pea seed proteins.

At that time, the United Nations' Food and Agriculture Organisation and the World Health Organisation declared there was likely to be a significant deficiency in protein, rather than in calories, in the human diet.

Legume seeds are an important source of plant-based protein, and so research on the amount of protein and its quality (amino acid composition) was an obvious way for Millerd, given her previous experience, to contribute to an important emerging issue.

Her significant research focussed on increased protein production: its nutritional quality, water requirement and the influence of soil composition on that production.

These were and remain significant matters of universal concern.

For her second sabbatical leave from CSIRO, she was awarded a royal Nuffield fellowship and became an overseas fellow at Churchill College, Cambridge.

After 20 years of research at CSIRO in Canberra, Millerd retired in 1982.

She had discovered skiing on her first trip to California, and it remained a lifelong (almost) passion. She was a member of the Blue Cow Ski Club in Guthega and Warrugang Ski Club in Perisher, and was active for many years in the ski patrol in both areas.

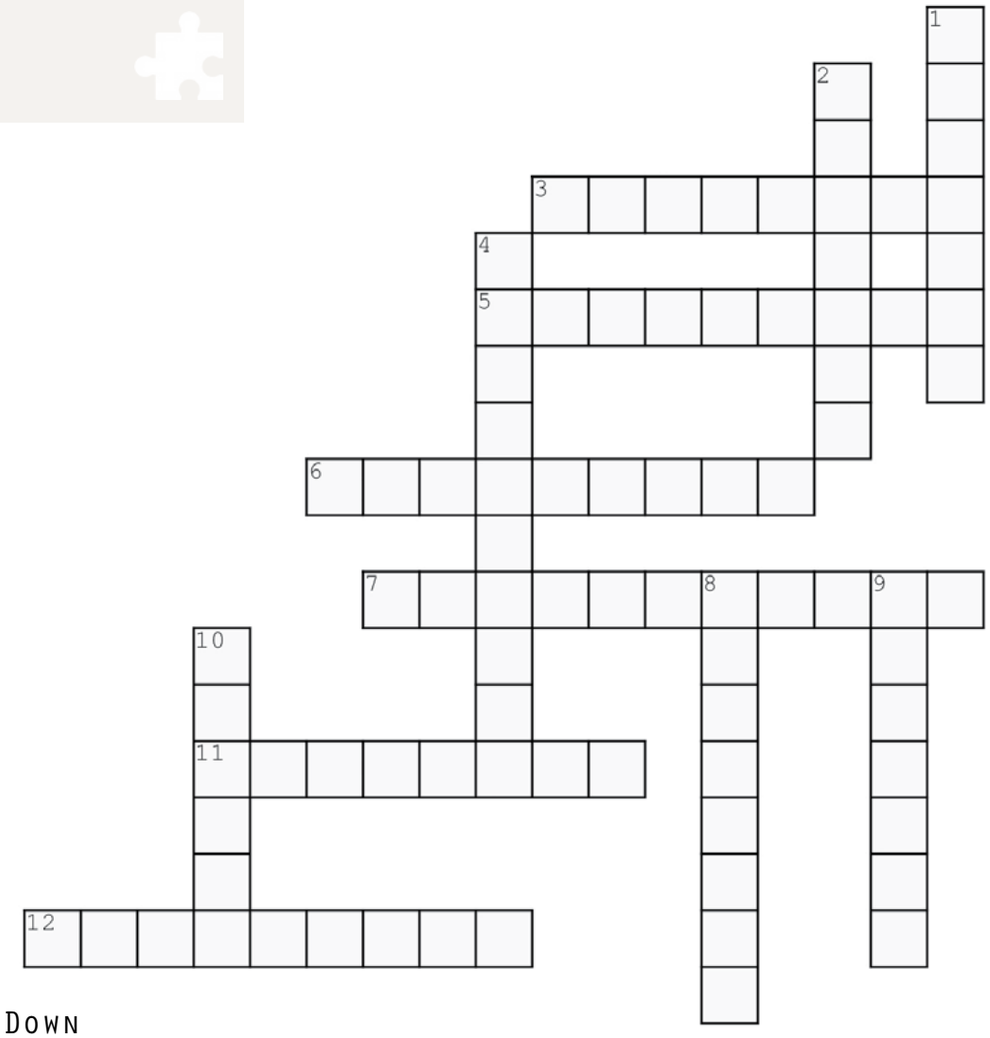
Millerd learned to speak Spanish fluently and travelled widely in South America. She also became an expert in computing.

As she had expected would happened, she developed glaucoma, a family disability, but was always determined not to be defeated. She adapted her computer to a large screen, listened to audiobooks and kept her mind active.

In May 2017, Millerd moved to Sydney to be near relatives, and it was there that she died.

She had many friends inside and outside of science. She was dearly loved and is greatly missed.

Margaret Goodchild, with Dr Peter Chandler, Dr Stuart Craig and Dr T. J. Higgins



Down

1.....To discard or put aside certain knowledge as being false or binding.
2.....Latin for the smallest possible discrete unit of any physical property, such as energy or matter.
3.....The study of the mechanical laws relating to the movement or structure of living organisms.
4.....The upending of traditional operating methods or systems in an industry, often through new technology.
8.....Australian cultural idiom that embodies equality, loyalty and friendship. Also what you might call a seafaring vessel with whom you are particularly friendly.
9.....Perceptible to the touch; tangible.
10...Relating to the sense of touch, in particular relating to the perception and manipulation of objects using the senses of touch and proprioception.

Across

3.....The act or process of introducing new ideas, devices, or methods.
5.....An organisation that helps people to start new companies, especially ones involved with advanced technology.
6.....A complex system considered from the point of view of the whole rather than of any single part.
7.....A semiaquatic, venomous pit viper found in the U.S. Also, an unpleasant sensation caused by insufficient hydration (or excessive ingestion of cotton..?)
11...The state or fact of existing, or occurring. In simulation or virtual reality terms, an elevated sense of 'immersion'.
12...The four-dimensional continuum in which all objects are located and all events occur, viewed as a single and continuous framework for existence.

November Solutions:

Down: 1. Vegemite 2. Purpose 3. Biomechanics 4. Accelerometer 8. Power 9. Kakadu 12. Lunar
Across: 5. Philosophy 6. Potential 7. Transformative 10. Membrane 11. Soldier

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