



Australian Government

Chief Scientist

DR CATHY FOLEY AO PSM

AUSTRALIA-ISRAEL CHAMBER OF COMMERCE

2022 PATRICIA KAILIS WOMEN OF ACHIEVEMENT ORATION

Looking beneath the surface – finding leadership within

Tuesday 15 November 2022

Perth, WA

Thank you for that kind introduction, Professor Hayne.

I'd like to begin by acknowledging the traditional custodians of the land on which we are meeting today, the Noongar people, and pay my respects to their elders both past and present.

And I would like to particularly acknowledge the value that Indigenous people bring to science and innovation. I can't emphasize enough the value of the need for genuine engagement with indigenous communities, to tap the well of Indigenous knowledge.

I understand we have a long list of VIPs here today, including the US Consul-General Siriana Nair, the Counsul of Greece Georgia Karasiotou, Denise Goldsworthy, Professor Lyn Beazley, Neil Kavanagh, and Robin McClellan.

I'd also like to acknowledge the members of Patricia Kailis's family here today, Maria and Amanda Kailis. Your family's entrepreneurship is legendary and you set an example.

I have known about the Kailis pearls and admired them for most of my adult life. They always reminded me of my absolute favourite books when I was a child – the Anne of Green Gables series.

Anne thought diamonds were purple. She was so disappointed when she discovered they weren't purple, that when she finally got engaged – this wasn't until book 4 – she insisted on having pearls for her engagement ring instead of diamonds.

As a child, this story matched disappointment and happiness, sorrow with hope. It feels to me that Patricia Kailis worked in both of those worlds. She brought such important advances for families trying to understand the genetic aspect of diseases, such as muscular dystrophy, Huntingdon's and motor neurone disease. She laid the groundwork for greater understanding in a very difficult area of medicine. And in another part of her life, she created and sold beautiful pearls.

It reminds me of those stories from my childhood, and I am honoured to be speaking at an event in her name.

It's great to be here in person today. My earlier plans to visit Western Australia were stymied by lockdown, and so this is my first trip in person since I became

Australia's Chief Scientist. However, I have done plenty of Zooming with the West over the past 18 months.

After I spoke at the National Press Club early last year, I received a letter from a group of women from Curtin and other universities. They wrote to me to challenge something I had said in answer to a question at that event.

At the Press Club, I spoke about Virginia Woolf "killing the angel in the house". Virginia Woolf talked about women being raised to think they need to fit in, not complain or criticise men, make the peace, make the sacrifices and, essentially, "eat the small chop". All of those things that are so familiar to us as women.

In their letter to me, that group of women took issue with the idea that women need to change their behaviour. They pointed out that the issue was not with women's behaviour, but with the structural problems in the system – including job insecurity, and the way tenure is contingent on winning a major grant in the early-to-mid-career stage, at precisely the time when many are also starting families. I set up a series of Zoom roundtables with the group to hear more. And what they had to say has had a big influence on me, and on the way I speak about diversity and about leadership.

When I was a young researcher at the CSIRO, I worked in solid state physics, where there were hardly any women, and for some years I was the one woman in the lab. I taught myself to adjust. To trim bits off myself so I wouldn't be a square peg in a round hole. But I have come to realise, and those women from Curtin really brought this home to me, that it is not me that needs to do the adjusting.

The research system, the ways we measure success and the bars we set for promotion, the ways we operate in the workplace – these are the things that need to make adjustments. Not only for the sake of women – so every woman, and every person, can make their best contribution – but also for the sake of the nation. So we can make use of the full human potential in solving our economic and social challenges.

Early to mid-career researchers have become my conscience, they are seeking to hold us all to account. So I have been much more forthright in that message since then, and more careful and precise when I challenge the status quo. And

I was delighted to have the opportunity yesterday to meet some of those women in person at Curtin University.

Also while I am in Perth, I will be speaking with the members of the research sector, including in quantum and renewables technologies, and members of the mining sector about the opportunities in critical minerals, renewables and quantum. These are absolutely critical sectors for our future prosperity and for science in Australia. They're especially relevant here in WA, and given the calibre of the audience today, I'm going to take the opportunity I have to say a little more about them.

Critical minerals are a topic of immense focus and interest at the moment. Just in the past couple of months alone, I've spoken at the International Minerals Processing Council in Melbourne, the first Australian Rare Earths Conference in Canberra, and the Regional Australia Institute's national summit. I visited Japan and Korea in October, where the supply chains for critical minerals and renewable energy were the top discussion item.

The reasons for this are pretty clear. As you know better than most, Australia is a gold mine not only for coal and iron ore, but we have some of the world's largest deposits of the minerals needed for batteries, wind and solar energy, magnets for offshore turbines and electric vehicles.

As I said to the Minerals Processing conference, we've come to talk about mining in Australia as an industry with an end-by date. But the reality is that mining is set for a boom. It's a different kind of boom, based on critical minerals and rare earths that are so important to achieving the energy transition to tackle climate change. It's a huge economic opportunity. But it requires, as we've heard Andrew Forrest saying recently at COP27, a different approach from the mining sector.

The new business model is not dig and ship. It's about midstream processing, which pulls those minerals up the value chain by processing them into refined materials suitable for use in renewable technologies. The new business model cannot be separated from the circular economy and the low-emissions goals. At the moment, many of the production processes for renewables are energy intensive. The processes for extracting critical minerals and rare earths is environmentally damaging.

It's no good solving one problem with another. Delivering the world renewable energy if we've used silly amounts of energy and degraded the environment in the process. That's not a solution, and not where global demand lies. I'm working with the Australian Government on a number of initiatives in this area, and I'd be very happy to discuss them with you in more detail.

I also want to let you know about the work I'm doing to realise the potential of quantum technologies. Again, this is an area of science that all of us need to be engaging with. The word quantum still has this futuristic feel about it – like it belongs only late in the evening, at get-togethers of the department of theoretical physics. But actually, we've been using quantum effects in various applications for many years now.

At the CSIRO, I led the team that developed a device used in the mining industry for remote detection of deep ore bodies. This device, called a SQUID, used quantum effects to detect the underground deposits remotely, while sitting on the surface.

So quantum effects are not new to real-world applications. But what is new is that we're on the cusp of being able to manipulate more quantum properties – to build the next generation of computers, exponentially more powerful than classical computers and ultimately much more accurate. These computers won't solve problems by approximating the real world; they will mirror the real world. We will be able to use them to build complex molecules, and then simulate the behaviour and interactions of those molecules. This will revolutionise personalised medicine, and really propel the process of discovery.

Quantum computers will be able to do calculations that are impossible for a classical computer – which is why there is urgent attention being given to the encryption methods that we use to protect sensitive information. The expectation is that those encryption systems will be useless in the face of quantum computing and we will need new methods of encrypting data.

Quantum sensing will unlock new capabilities in mineral exploration, and many other sectors.

Quantum technologies will infuse every aspect of our lives in the years and decades to come, and allow us to really see beneath the surface. I mean this in

a literal sense – for underground and underwater mapping, but also in the sense of being able to see the way the world works at the tiniest scales.

I'm working with the federal government and the states and territories to ensure Australia is at the forefront of the quantum revolution. Australia can't afford to be the follower in this technology. We have set ourselves up well with over three decades of world-leading research. And now all of us in business, research and government need to be on top of it – work to understand the potential and it will impact us, and incorporate it into research and business planning.

Let me come to the topic of my speech: "Looking beneath the surface – finding leadership within." I'm speaking to a room full of leaders, and people of really significant and eminent achievements. You will have many insights that I hope you can share with me during the discussion a bit later.

What I want to share with you are some insights from the world of science. These are insights that, in my view, are useful well beyond the world of science, to all organisations. I never cease to be amazed at what science can do – and at the way discoveries build on each other and lead to totally unexpected outcomes. It was Einstein's discoveries about light that led to quantum science.

One aspect of my research was developing an engineered grain boundary interface called a Josephson junction – and I still find it amazing to see how the technology is built on. This is the basis of a lot of careers and research here and overseas. It's the basis of work in satellite communications, broadband antennas, x-ray vision, and medical imaging. There's a ripple effect.

I really value that process, and it's why I'm such a big proponent of supporting basic, or fundamental research. You never know what it might lead to.

A second thing about science that I love is that sense of awe when you discover something new and almost unfathomable – and then it dawns on you that the discovery was made by a scientist, a human-scale scientist.

The Square Kilometre Array – way out there in the silence of Murchison – is in this category. There are not too many places on earth where electromagnetic noise is low enough for a radio telescope of this kind. When the CSIRO did its test run using the Square Kilometre Array Pathfinder (ASKAP) telescope, it

collected one quintillion bytes of data in 10 days. That's 1 with 18 zeros, or as the CSIRO explained, it was the equivalent of watching Netflix for 100,000 years. In that 10-day test run, the array detected one million new galaxies. And when you remember that our own galaxy has somewhere between 100 billion and 400 billion stars – well, it's just mindblowing.

There's a third thing about science that I love, and it's something I learned when I was very young – when I discovered my brother's Harry Messel high-school textbooks. I spent hours reading those textbooks and studying the diagrams. And I realised then that science could help little people, like my 9 or 10-year-old self, make sense of the world. Science enables us to look beneath the surface, understand how things are put together, and how you can put them together in new ways to solve problems.

I think Patricia Kailis understood this. I read that when she went to Broome with her husband to develop a pearl farm, they came up against a problem with disease in the oysters.

What do you do? You strip it back and look beneath the surface. She applied what she knew from medicine. Stainless steel workbenches, clean and careful work practices. She treated the oysters with care and solved the problem.

This is what science is about. If something's not working there's usually a reason why. So you take it apart and work out why.

So these are the insights I offer from science. It's a process where discoveries build on discoveries to unexpected outcomes – and those outcomes are bigger than the sum of their parts. It's a process driven by curiosity that allows you to look underneath the surface to see how things work. It can help make sense of the world and solve problems. And all of this is precisely what we need now, given the scale of the economic shift in front of us.

I do not underestimate the difficulties. The energy transition is a massive challenge. Online threats are testing our ability to keep up. The emerging industries require a major step-up in skills and investment. All of these things are top of mind for all of us.

But as a scientist, committed to discovery and to progress, I know we can navigate these challenges to a better outcome. This is because as the impacts

of climate change have become visible, a unity of purpose has developed about the need for change.

This is now a shared mission, not only here in Australia, but around the world. Global connectivity has brought some very damaging impacts. But it has also brought a transfer of power from institutions to individuals.

When crowdsourcing is being used to raise money to supply the Ukrainian army with drones and body armour – or when you see Sean Penn giving Zelensky his Oscar – you know something has changed. The levers of democracy are in new hands. They're in our hands more directly than ever. And so the question becomes for each of us as citizens and as leaders, how do we use these levers most effectively? How can we contribute to the shared ambition for change?

First, we recognise this moment for what it is. Because – as I said last week when I spoke with a group of leaders in engineering – Australia's task is not simply to get better or more efficient at things we're already doing, or refine existing competencies and technologies. The task is change the way we're doing things. We don't have all the tools in the toolkit yet to reach net zero. To meet our 2050 target, we need new discoveries, at that level of fundamental research.

We are on the cusp of quantum breakthroughs but we're not there yet. A fully error-corrected quantum computer is still a difficult task that scientists around the world are working on.

We don't have the technologies we need to extract critical minerals cleanly, or to deal effectively with waste.

This means it's not a moment for more of the same, to fall back on old models and ways of doing things, even if they proved trusty in the past. To realise these technologies, we need to invest in the process of discovery, at the same time as we pull discoveries through to real-world applications, and scale up to where we need to be.

We engage with risk, by recognising the value of fundamental research and the importance of supporting it. And understanding that not every avenue of inquiry will yield a positive result. We need to be comfortable with unpredictability, because as I said a little earlier, you can never be quite sure where a discovery will lead.

This doesn't mean throwing caution to the wind. It's a good principle to measure twice and cut once. But it means being adventurous in our choices, in the way we run our organisations, and where we choose to invest. Having the courage to imagine a different way of doing things. This is how we become competitive in those frontier sectors. And it's where the gold lies. So, that's the first task for leaders in business and government. Invest in discovery and be comfortable with unpredictability.

Then, incorporate a broad set of inputs and ideas. This will ensure we're using the full human potential, the knowledge that resides in every part of the community. So many of our human interactions are based on first impressions, which means they are coloured by sex, culture and age – and we gravitate towards people like ourselves. But if we are going to find novel solutions, if we're going to build a digital world, and a world where artificial intelligence and robotics place an ever-larger role, we need to look outside our comfort zone for people who are not like ourselves. We need to look for fresh ways of thinking.

This means full engagement of older people as well as young people. People from diverse cultural backgrounds, and people who are neuro-diverse. It means making use of the skills and experience of women at all stages of their careers.

As that group of university women said to me last year, women's careers stall when they start having children, or when they try to navigate the workplace hierarchies based social structures of the past. My mother was forced to resign as an architect with the NSW public service when she married. I understand that when Patricia Kailis got married, she worked as a GP without being paid because it wasn't considered appropriate for her to be earning.

It's Virginia Woolf, down through the generations! Eating the smallest chop. For women in today's workplace, it manifests in obvious ways but also in more subtle ways – names on research papers or grant applications in the research world; expectations of leadership styles in the corporate world. As Australia's Chief Scientist, I accept the need to talk often and forcefully about diversity. But as a woman, I wish I didn't have to.

As leaders, these are levers we can pull. We can make a difference through supporting discovery, taking measured risks with new approaches, and inviting fresh thinking in our inner circles.

I have spoken today about the opportunity in renewable energy and critical minerals to lift the complexity of our economy, to create new jobs, and to solve problems of environmental degradation and climate change. I also spoke about the potential of quantum technologies in bringing transformative change.

There are other sectors – biotechnology, space and artificial intelligence, where Australia has significant ambition. I'm confident that we can achieve these ambitions and get where we want to be. But it will take the right focus, the right investment, and a collective effort. It is a shared responsibility that each of us must shoulder.

The economy is changing. Capabilities and technologies are changing. The shape of the workforce, what we need from the workforce, and expectations are changing.

Science can work miracles. But science can't do it alone. Nor is it the sole responsibility of government or of business. Each sector in our economy, each person with influence in an organisation, has the responsibility for making changes in mindset, in approach or in practice. It's a shared responsibility.

So I am going to re-cast the comments I made at the National Press Club. No-one should have to trim bits off themselves to fit the status quo. Instead, each of us in a position of influence has a responsibility to be curious about the status quo. To look beneath the surface.

And be prepared to strip back those layers of systems and practices that have built up over many years – to consider, which of those ways of doing things will serve our collective ambition, and which will not.

Thank you.

##