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NATIONAL PRESS CLUB ADDRESS TANYA MONRO 27 MAY 2020

SABRA LANE: Good afternoon, ladies and gentlemen, and welcome to the National Press Club of Australia and today's Westpac address. My name is Sabra Lane. I am the club's President. I'm also the presenter of the ABC radio current affairs program, *AM*. Today's guest is Australia's Chief Scientist, Professor Tanya Monro. If you're following the conversation online, you'll find us on Twitter - our user handle is @PressClubAust, and you could use the hashtag, #NPC. Everyone, please welcome Professor Monro.

[Applause]

TANYA MONRO: Sabra, thank you for that kind introduction. First, I'd like to acknowledge that this is National Reconciliation Week, and that Reconciliation Australia has reminded us that, whether in crisis or in reconciliation, we are in this together. And it's important to show respect to country wherever we are. Today, I'm speaking to you from the land of the Ngunnawal people, and I pay my respects to their elders, past and present. I also pay my respects to Aboriginal and Torres Strait Islander people who have contributed to the defence of Australia in times of war and peace, and acknowledge that they are, indeed, some of our very first scientists and engineers and innovators.

Ladies and gentlemen, since 2011, nine people have had the privilege to deliver the Ralph Slatyer Address. This esteemed group has included distinguished professors, a former prime minister, and a leading public servant, and I'm delighted to be the 10th speaker to usher this series into a new decade. My sincere gratitude to Tony Peacock for the invitation to speak today. And I would like to acknowledge the staff of the CRC Association and the board of directors superbly led by Belinda Robinson. I'd also like to start by thanking the National Press Club, particularly Chief Executive Officer Maurice Reilly, the management team, President Sabra Lane, and the board of directors. I'd like to acknowledge, warmly, that we have Ralph Slatyer's son, Tony, here today. Thank you, Tony, for coming to this

address in honour of your father. Thank you to the members of the press here present, and to Australians watching from home.

As I mentioned, today, through the tradition of this address, we honour the memory of Ralph Slatyer. And while the face of the speaker changes year on year, we are all charged with reflecting on science and society. Science draws people together and harnesses ideas to solve some of our biggest problems. Science has transformed lives and taken us from being nomads to agrarian societies, right through to today's deeply connected world. Science has lifted us out of poverty, cured diseases, and put man on the moon. What is science? Well, it's the ability to predict, to analyse, to observe, and to experiment. And in the process, it's very exciting because we extend the limits of knowledge. We develop new technologies and we solve problems. It is the nature of science to challenge orthodoxies, question the established order, and up-end the status quo. For example, Copernicus' contention that the planets and the Earth circled the sun caused theological consternation for centuries and led to Galileo being under house arrest for life. And in fact, it wasn't until 1992 that he was formally cleared by the Vatican. Einstein's utterly transformational Theory of Relativity never did win him a Nobel Prize. And Darwin's notions of natural selection were considered heretical by some. We do continue to be fascinated by science. I think this is because it allows us to channel our instinctive curiosity and our creativity. I see science as the art of the possible, of what might be.

Science, in itself, is not an unadulterated force for good. It can be abused and misused. As Shakespeare said, there is nothing either good or bad, but thinking makes it so. But at its heart, science is the search for truth and for solutions. This search pulls us together in a cooperative way to solve problems, and the collaborative nature of science is something that Professor Slatyer understood well. It is why he championed the concept of Australia's world-renowned Cooperative Research Centre Scheme, and in doing so, Professor Slatyer, I would say, was ahead of his time. He appreciated the increasingly complex challenges of the future, require the distinct strengths of academia, industry and government all to come together for a common cause. Today, I'll be showing you how defence science is doing just that: bringing together the interdisciplinary expertise from across our nation, to undertake mission-oriented research and solve some of Australia's most pressing problems. So, to honour this event's tradition reflecting on science and society, today, I would like to explore defence science within an Australian context.

But first, a few words about Professor Slatyer. Ralph was initially appointed by Prime Minister Malcolm Fraser as Chair of the Australian Science and Technology Council or ASTEC. This part-time position was essentially the PM's Chief Science Advisor. And when Bob Hawke's Labor Party came to power, he decided to keep Ralph on. Hawke wanted to

have an advisor on tap full-time, and he established the Prime Minister's Science Council and Coordination Committee. Eighteen months after Ralph finished as Chair of ASTEC, he accepted the first ever role for Chief Scientist for Australia – a role that Alan Finkel performs so capably today. The Chief Scientist provides that advice to the PM and other senior ministers. They champion Australian science and promote it overseas and make sure that Australians growing up have the opportunity to benefit from learning science at high levels. It's fair to say it's a tough gig, but it's one that Ralph did masterfully with poise and discernment.

A very small part of Ralph's legacy was the way he set me on my career trajectory. As I mentioned, one of Ralph's lasting legacies was establishing the Cooperative Research Centre Scheme. One of the very first centres was in the field of photonics, looking at how Australia could develop some of the technologies that could be used to improve telecommunications. Now, as a student, I was excited by physics and I loved maths. I was intrigued by the study of forces and energy, of nature and the universe, of space and time. But I wanted it to be real. I wanted to be able to link my intellectual inquiry with tangible outcomes. Luckily for me, I had the opportunity to do that within the Photonics CRC. It was a vibrant environment in which young research scientists could work together with engineers and industry to take ideas and to pull them through into tangible, real outcomes. For me, that experience was a revelation, an awakening. I found myself realising that I could create ideas that made a difference. And soon after, my PhD landed me in the UK. I went to work at the University of Southampton, with the research group that arguably developed the optical fibres used for telecommunications systems today. Like the very veins and arteries that carry blood around our circulatory systems, optical fibres do this for telecommunications, carrying vast amounts of data around our globe.

Now, we must have been doing something right, because every week, industry came banging on my door. And, equipped with this experience, I came back to Australia, to the University of Adelaide in South Australia, to work with the Defence Science and Technology Organisation, as it was known then. My mission was to establish a photonics research centre that developed some of the optical materials, optical fibres, sensors, and new kinds of lasers that Australia needs for its defence interests.

One of the very earliest projects Defence proposed was to see whether we could use light to monitor corrosion within aircraft. Now, to do this, we had to work very hard to create an interdisciplinary team over a decade that led to some quite surprising and unexpected discoveries and outcomes. For example, the development of water-quality sensors, a virus diagnostics, and smart IVF incubators. But perhaps most critically of all, being in South Australia, we developed smart bungs that could sense the maturation of wine in barrels.

Throughout all of this, I learnt two things. And the first is that, when researchers work hand in hand with the people who use that research, you get new insights, new inspiration, can ask different questions. And when those end users work hand in hand with the scientists, it makes it so much easier to translate those discoveries into tangible outcomes. In Defence science, it's imperative that our primary focus be on the Australian Defence Force. They are our customers, our end users of our research. And that's how we meet the needs of our nation. And that could be in terms of new Defence capability, or supporting things like the current COVID-19 environment or responding to bushfires. Defence science in Australia, as both an organisation and an institution, is 113 years old. And just recently, we celebrated the 80th anniversary of our Fishermans Bend site in the busy industrial district of Port Melbourne. With just over 2000 staff across the country that were described by Minister Linda Reynolds a few weeks ago in *Question Time* as some of the smartest men and women in our nation, we are Australia's second-largest public science agency.

And last year, I had the great honour of being appointed as Australia's Chief Defence Scientist. My job is to ensure that through science and technology, we support the development of defence capability and meet defence and national security needs of our nation. And in doing so, we help the ADF defend Australia and its national interests. Now, in the past, a nation's ability to defend its interests and deter its adversaries, defeat its opponents, were largely determined by the count of aircraft, warships, and boots on the ground. And as observed by the Napoleonic-era Prussian strategist Karl Van Karsovic(*), military advantage was about mass, weight, and the concentration of force. However, today's technological developments and the world's hyperconnectivity are transforming the characteristics of warfare. The deterrence that was once afforded by distance has now given way to the perils of proximity. Nations and non-state actors can employ cyberattacks and other elements of hybrid warfare that exploit that grey area between peace and war. And the emergence of new technologies and capabilities like hypersonic weapons, high-speed and long-range missiles, and machine learning increasingly challenges those traditional military capabilities. All of this is playing out globally, but especially in our multipolar dynamic complex Indo-Pacific region.

Today, military advantage is contingent on information, data, intelligence, speed and networks, preparedness and adaptability. To prevail in this contested environment, Australia needs a modern military force equipped for modern warfare. And I would contend that the role of Defence Science and Technology in the defence of our nation has never been more important. But we cannot do this alone. Rather, we must draw on the best ideas and the innovation potential of our nation. So with all of that in mind, I'd like to share our work with you. We have extended Australia's horizons. The Jindalee

Operational Radar Network, known as JORN, consists of three over the horizon radar systems. These electronic sentries surveil Australia's northern sea and air approaches, scanning out to between 1000 and 000 kilometres. Now, defence scientists started researching JORN technologies about- well, back in the 1970s, about 50 years ago. And it began operations 20 years ago.

Unlike traditional radars that are limited by line of sight, JORN makes use of the ionosphere above the earth's surface to bounce high-frequency radio signals. Our scientists have partnered with a team from the University of Adelaide that has developed a cryogenic sapphire clock. This clock is so precise that it only gains or loses a second every 40 million years. With this unparalleled precision, we can be confident that future upgrades to JORN will allow us to continue to lead the world in this technology.

Now, turning to our air capability, which is crucial for the defence of Australia. The 2016 Defence White Paper made the compelling case for a potent and technologically advanced air combat and strike capability in the form of a fifth-generation Air Force. But how do we ascertain the life of an aircraft? How do we know it remains safe to fly? Because if we retire an aircraft too early, it costs money and we jeopardise capability. If we retire an aircraft too late, we put lives at risk. What's the goldilocks zone? Well, back in 1949, one of our scientific engineers wrote a paper, and that paper was called *The Life of Aircraft Structures.* His colleagues then went on to test 221 Mustang fighter wings and wrote a manual about aircraft fatigue. Both of these publications gave birth to real expertise here in Australia, which has enabled our aircraft to fly further for longer, and extended their service life by many years. And since that time, we have saved the Australian taxpayer tens of billions of dollars supporting the safe life extension of F-111s, FA-18 Hornets, Hercules, and Orions, and other aircraft. Today, we're using the same principles to extend the life of our latest jets - the F-35 Joint Strike Fighter - so that our nation can get the very best capability from the world's most sophisticated stealth fighter.

What about protecting our troops? Well, every single day, Australian soldiers use metrics developed by Defence Science and Technology to reduce the risk of injury or death from heat stress. And when our soldiers are on active duty in the Bushmaster armoured mobility vehicles, these four-wheel drives may soon be protected from explosives by - wait for it - water. An armoured vehicle on patrol carries hundreds of litres of water so that our engineers thinking, how do we make it safer, popped to Bunnings, bought some jerry cans, and tested what happened in an explosion. They demonstrated that if you positioned the water in the right place, [audio skips] more energy, and thus, help protect its crew. Who would have thought that water could form as an alternate form of armour? To me, this is quintessentially Australian innovation. Defence's confidence in the Cooperative Research

Centre model established by Professor Slatyer is demonstrated through our establishment of the first Defence CRC entrusted autonomous systems. The CRC was established under the next-generation technology fund and has had $50 million worth of Defence investment over seven years. It brings together industry and researchers to work on next-generation machine-human teaming so that we can amplify the effect of single humans in difficult, contested environments.

So, where are we headed? History tells us that predicting the future is difficult and, indeed, less than eight years after the Wright brothers first piloted those self-powered aeroplanes, Ferdinand Foch, the French general and military theorist declared that, while aeroplanes were interesting scientific toys, they are of no military value. He would go on to become the supreme allied commander in the First World War.

In my own field, photonics, when in 1960, the laser was first invented in a lab, it was thought to be simply a scientific curiosity. But I'd challenge any of us today to go through a day without sending photons scurrying around the world as we do a Google search, or using light when we buy our groceries at a supermarket checkout. But in Defence, our responsibilities require us to make predictions, and to explore how technologies might evolve into the future. So what we do is we continually assess and predict, and reassess the strategic environment. We make forecasts on technology development, which we call tech road mapping. We do all of these things to anticipate the challenges to our nation and make sure that we are prepared for future challenges. Australia's military is a modestly-sized defence force in globally comparative terms. And as a middle power, Australia plays an important role in ensuring a more prosperous, secure, and free Indo-Pacific region – one in which the global rules-based order and the sovereignty of nations is respected, and one where there is cooperation and economic interdependence, not confrontation and conflict. Therefore, our defence forces need to be capable, agile, and potent.

So, how does defence science support this requirement? Well, earlier this month, Minister Linda Reynolds launched the new Defence Science and Technology Strategy, which is called More, Together. Traditionally, much of Australia's R&D has been bottom-up. And, unlike many nations, much of our R&D happens in our universities and relatively little in our industry. This new strategy, More, Together, seeks to invert that process. And the core concept in the strategy is the concept of missions that can focus and grow scale around some of Australia's biggest problems. We have named these missions Science, Technology and Research Shots, or STaR Shots for short. And just like the Moon Shot inspired a generation to study science and engineering, the STaR Shots aim to be aspirational and inspirational goals. They’re devised to unlock the creativity of Australia and shape and align

the research that happens in our universities and to support the development of industry capability.

For these STaR Shots to be successful, we must harness research expertise from across the country, both in our universities and in our publicly-funded research agencies. I'd like to give a couple of examples. Many of you would remember those scenes from World War I and II movies where the generals synchronise their watches before an attack. Today, our forces use the US GPS system to do the same thing. We use that system for precision-guided weapons and to coordinate and synchronise distributed forces. The timing aspects of these systems are used in communications, in cryptography, to time-stamp intelligence and to synchronise distributed computer systems. And when that's under threat due to conflict, we just don't have an alternative. Another problem with GPS is it doesn't work in all environments, whether that be underground, underwater, or in a complex urban setting. So, what happens? What do we do if we lose GPS? Well, the quantum-assured position navigation and timing STaR Shot is being developed from what we sometimes think of as the second quantum revolution. We're looking to harness the unprecedented sensitivity we can get through sensors – things like gravity meters, accelerometers, magnetometers and precision clocks. It's expected that these are some of the ingredients we need to be able to generate an alternative to GPS. But we cannot do this alone just through Defence. Connecting with industry and academia is absolutely fundamental, and we recognise that Australia has world-leading R&D in our universities in this area. We've also established a global cooperation program with the UK, the US, Canada and New Zealand, with a really clear and concrete goal to bring together these technologies in a demonstration on a New Zealand frigate in 2024, which is not far away, and demonstrate what does and doesn't work. Where will we be in 10 years? We will have an alternative to GPS, and it will operate in contested environments and give that assured position navigating and timing that we need. This is an amazing opportunity to really harness real strengths Australia has and deliver industry capability and real capability for the ADF and save Australian lives.

What about space? Well, in November last year, NATO formally declared space an operational domain. Space provides important capability for Defence because we use it for comms, for position, navigation and timing, and to get earth observation products. But space is changing and fast. As well as becoming contested, it's becoming congested. These traditional satellite capabilities we rely on are becoming challenged and new technology is required. So, enter(*) the space STaR Shot, which seeks to develop resilient, smart satellite networks to allow the ADF to get data wherever they are on the globe. To achieve that, we have to develop a lot of autonomous technology that works in space. We'll also put technology in space that helps manage congestion by automatically manoeuvring to stay

safe. Defence science has its own embryonic space capability. We've been building satellites and have launched one successfully, and have another launch coming soon. But that's not enough. We're seeking to build a sovereign, industrial capability to provide increased space capability for Australia.

And to do that, we need to partner with great minds nationally and internationally. This is why defence science, through the Next Generation Technology Fund, invested $12 million to leverage just over $250 million of co-investment from industry, from universities, from government. And this allows us to do something that has not been done before in Australian history. It is the single biggest investment in space technology development in our history. These smart satellites will have significant application beyond defence. They will help us manage the quality and quantity of water resources across the country. They will help our farmers and our miners precisely control heavy machinery from hundreds or even thousands of kilometres away. And they will also support emergency services when conventional comms are overloaded in a crisis, as we've seen recently. Through this STaR Shot, we're also partnering with the Australian Space Agency, which was opened formally by the PM in February this year. This will help us build some of the new space infrastructure we need to support the nation's space requirements and aspirations. All of these activities mean it's a very exciting time to be interested in space in Australia. And, indeed, we're working to inspire the next generation of Australians to consider studying STEM because we know 70 per cent of future jobs will need it.

These are just two of our eight STaR Shots. We've just selected the leaders who are charged with bringing together the nation to come up with wonderful, crazy ideas, to fast-fail them, and to develop enduring capabilities for the nation. [Audio skip] Please go to your website and have a look at the leaders for each of these STaR Shots.

Having ruminated on the future of defence science, this mission-oriented delivery of capability for Australia, I'd like to return to the present. Recently, we've aided Defence's response to support the frontline services during the horrendous ‘19-‘20 bushfire season and the COVID-19 pandemic. As homes and lives were lost due to the fires, Australians would have seen the camouflage uniforms of the ADF supporting and assisting their colleagues in the yellow and orange attire, the firefighters and the State Emergency Services. And at the peak of Operation Bushfire Assist, there were more than 6500 servicemen and women, including about 3000 reservists, supporting relief, response and recovery efforts. While Australians would have seen that wonderful ADF contribution, you may not have realised that defence science was there playing its role. Over the Kangaroo Island and Gippsland fires, there was an aircraft flying – a Defence experimentation airborne platform that was undertaking missions using some of the country's most

sophisticated sensors and cameras. Flying above that burning landscape, the crew used the aircraft's equipment to look through smoke and provide the information on fire intensity, movement and damage to other firefighting aircraft, and ground emergency responders. We also demonstrated the ability to spot fires when they were less than a metre across. This will help us respond to future bushfire seasons, which we know, sadly, will come.

From the bushfires to the current pandemic, each year Defence scientists help model and predict the scale of the influenza season, and that experience has allowed us to make important contributions as part of the national response to COVID-19. We contribute through providing modelling to the Australian Health Protection Principles Committee, and similarly working with colleagues at the University of Melbourne and the University of Adelaide, we've developed forecasting on how transmissible and severe the virus is likely to be in Australia. We also work with CSIRO to understand how long a virus can survive on surfaces such as banknotes.

In late March, I was tasked to lead a rapid response group to help increase domestic stocks of invasive ventilators. Simply put, invasive ventilation involves a tube helping a critically ill patient when they can no longer breathe on their own. Within a space of about three weeks, our wonderful engineers had designed a device that could convert the existing stockpile of non-invasive ventilators into those invasive ventilators for use in intensive care units. This involved fast-failing a number of prototypes and testing their safety in partnership with universities and medical professionals. And this device now stands ready to be manufactured, should the need arise, whether that be within Australia, or some of our neighbouring nations.

Defence Science also partnered with a family-owned South Australian business called Axiom Precision Manufacturing to produce face shields for healthcare workers on the front line. We designed and prototyped these face shields using 3D printing and rapidly transitioned them to Axiom, who could then mass-produce them using injection-moulding techniques. A wonderful story coming out of this is that not only were these Australian-designed and made face shields made here, and quickly, but they were more comfortable and cheaper than imports. And the first batch of 600 face shields went to South Australian hospitals for evaluation, and 4000 are now being produced. This is just a set of examples of how we, in Defence, are working across industry and academia.

So, ladies and gentlemen, when I reflect on Defence Science, I'm really excited about the role we play in shaping Australia's future, and the relationships we're fostering. We're partnering with all 37 of Australia's public universities under our new Defence Science Partnering Deed. We're deepening our partnerships with the other publicly funded

research organisations like CSIRO(*), ANSTO, the Bureau of Meteorology, and other associations like our learned academies. We currently have 12 strategic alliances with major Defence primes, and work across multiple cooperative research centres, and a growing range of small-to-medium-sized enterprises. And it gives me great joy to see some wonderful science coming out of DST being turned into start-ups, and starting to create new small-to-medium enterprises.

As Defence Science and our partners continue to work collaboratively in a mission-oriented way to develop capabilities Australia needs, I believe we will grow the alignment between Australia's wonderful R&D capabilities and these big problems. But this is going to take cooperation and time and commitment. Our research and development will provide the country with powerful new technologies that will find clever and unanticipated uses in other areas, such as health, agriculture, mining, and environmental monitoring. But it will also build new capabilities in industry and research, and I hope, inspire more kids to study the subjects that set them up for wonderful careers.

I'd like to acknowledge the Prime Minister's remarks right here yesterday at the Press Club about building on Australia's world-leading strengths, and about the really critical role that research and development play in setting up Australia for economic success. Defence Science will give our men and women a capability advantage so [audio skip] in that challenging, contested environment. So, is Australia up to the challenge in this changing world with ever-increasing uncertainty? Well, my reflection on the challenges we've risen to - whether that be bushfires or COVID-19 - is abso-bloody-lutely(*) because there's nothing like a problem. And you give our nation a problem, we come together to solve it.

Ladies and gentlemen, thank you for your time.

[Applause]

SABRA LANE: Thank you for that, Professor. Before we get on to questions, I'd just like to note the National Press Club welcomes the breaking news that's just happened while we've been up here, that the Australian Federal Police have announced they will not lay charges against News Corp journalist Annika Smethurst - Annika is also a board member here at the Press Club - after their investigation into leaked documents. We welcome that development.

[Applause]

Now, I've got a couple of questions to you first, before we go to questions from the floor. How much is cyber theft a threat to Defence Science and what we're doing here?

TANYA MONRO: Cyber threat is certainly something that we need to be on top of. Now, we have wonderful capability in government, through organisations such as ASD, to make sure that Australian businesses, and what we do within government, is protected. It's always the human that is the weak spot in the loop. And that's why, within Defence, we have a very high level of hygiene around how we deal with information and how we deal with security. It's something that we're very conscious of as we go out in partnering to make sure that we work in a way that keeps critical information secure for the nation. It's something that I think about a lot and that worries me, because if we're to generate ideas within Australia, we need them to be used for effect within Australia, and not lost. So, it's a critical problem. It's always under threat. And you always have to be vigilant and use best practice.

SABRA LANE: Another question I have is really in regards to nuclear capability - that keeps popping up in the conversation. Does your organisation examine that possibility here, even though regulations currently restrict the use of nuclear material in, say, submarines and future submarine development?

TANYA MONRO: Our role within Defence Science and Technology is to develop technologies within the policy context of our nation. And it's extremely clear that, at the present time, the policy context is not nuclear, whether that be our subs or other energy considerations. We are very well plugged in and connected to the global research networks and, if ever that policy position were to change, we would work with partners internationally to gain that knowledge. But that is not something we focus on at present.

SABRA LANE: You are also the first female Defence Chief Scientist. Congratulations on achieving that. I did a little bit of research today and discovered that you have quite an accomplished record - that, at a young age, you looked first at perhaps being a cellist. Science wasn't on your radar at all, and you won a scholarship, but your mum intervened at one point, unhappy that you were looking to continue your school studies without doing science. How did you end up becoming hooked on science and physics?

TANYA MONRO: I think my mum is watching and she'll be thrilled to have been mentioned on national television so thank you for that. Indeed, music's a great passion for me and my three children are all fine young musicians. For me what got me hooked was an amazing physics teacher and so many scientists have the same story to tell, just the transformational power of a great teacher. Suddenly I could see that my love of creating,

you know I used to compose, I love to build things, was something I could do through science that maths was the language of the universe and that physics was a way of asking questions about that universe, and to me suddenly creativity was alive in science. And it's probably easier to be an amateur cellist and pianist and a professional scientist than the other way around but it brings great joy. And I just hope we can find ways through some of the really exciting problems we're working on to get more kids excited about what they can do in science because I find that once staff come in the door and see what we work on they tend to not want to leave.

SABRA LANE: And as I say you've got a very impressive record I think you've got the PhD by the time you were 26. You've got three children two of them are twins. I'm going to read this snippet for the audience because I think this is pretty gobsmacking. This is a piece that I got from the Cosmos magazine and it's a quote. If I can manage a team of 30 people remotely dealing with multiple industry requests and grants and postdocs and students, have a two-year-old at home, be expressing milk for my two premature twins and dealing with acute reflux throwing up half what they ate for 11 months, and sleep deprivation and the fact that you get one twin to sleep then the other one wakes up and then you've got 20 emails to answer, and the minister wants to speak with you, if you can do all of that you can do anything. I reckon you can do anything. And I reckon I can hear an audible you rock lady around the nation at hearing that quote. What is the best advice that you can give to bosses and workers about that, women who are trying to juggle amazing careers as well as family life?

TANYA MONRO: What a wonderful question and it's something I'm really passionate about. Recognise what they can do and be flexible in how they do it. You know, I think the current COVID-19 working arrangements is pushing us as a society to recognise delivery and outcomes rather than just being physically there. You know, that made such a difference to me when I had a young family. I remember when I returned to work after maternity leave with my first child and I at one point was working four days a week, and the boss came up to me and said are you happy working four days a week? And I said it's perfect, I feel like I'm making progress but I still get to meet with other mums and have more time with my baby. And he said good we'll call that full time. And it wasn't really about money, it was about recognition that you can deliver in a flexible way and having that recognised just gave me so much energy and I wanted to give back. So it's about flexibility. It's about recognising delivery regardless of how it's delivered. And I'd also say it's about as an individual, just not being too hard on yourself. Deliver, do what you can do in the moment. Reprioritise on the fly and only worry about what you can control.

SABRA LANE: Sara Eisen.

QUESTION: Sara Eisen from *The West Australian*. Thank you so much for your address. You mentioned the PM's speech yesterday. On that he flagged looking at skills and skills training and really reviewing and potentially reforming that. How big a priority do STEM skills need to be? Do they need to be top of the list when it comes to doing any reform in that area? And just a second question, you mentioned defence. Science has been doing some forecasting and modelling of COVID. How much did the virus play out against what was predicted? Did the modelling predict something much, much greater and actually what we're seeing is much less than we expected?

TANYA MONRO: Thank you for those fabulous questions. So the first is STEM skills and I would argue that the set of skills that we need most in our next generation. And that's not just because we need some much larger numbers of scientists in labs but it's because the ability to look at growing volumes of data and evidence and make good decisions as technology develops fast, is ever more important. So if we have a future where our decision makers, our leaders of industry have a better level of training in STEM skills, we will be able to make better decisions as a society. And there are more jobs coming. Now on pandemic modelling, it's quite sophisticated and has a lot of parameters as you might imagine and one of the ones that perhaps is always the most difficult to grapple with is the social aspect. How compliant will people be with restrictions? How compliant will people be with handwashing and personal hygiene? So when we do modelling we do make assumptions about that level of compliance. And I'd have to say I've been thrilled with how well Australia has responded. It's been extraordinary and I think the key is just that we cannot be complacent because it doesn't take long for numbers infected to bounce back up and have for the replication numbers to be over one again.

QUESTION: Did the spread of the virus meet the expectation of the forecasting? The numbers themselves of infection in Australia.

TANYA MONRO: It's within the bounds given the uncertainties in the social aspects such as compliance to restriction. So the modelling does hold up and is always refined and always updated. And probably one of the most important things is that defence science has been bringing in expertise from the international counterparts so that we can learn from what other countries are facing where there has been greater spread to check our modelling for Australia. Thank you.

SABRA LANE: Simon Grose.

QUESTION: Simon Grose from Canberra IQ. The biggest procurement project at the moment for- across all portfolios is what the Government's chosen to call the Future Submarines Project. It's a- they're going to have a very old fashioned power system. They're going to be a cobbled together one-off nuclear platform with a non-nuclear power function. They're going to be probably in the water, the first one in about 20 years and in the context of where underwater warfare is going to be dominated more and more by drones. How as Chief Scientist can you justify calling it the Future Submarines Project? Wouldn't they be yesterday's submarines when they're actually in place?

TANYA MONRO: Thank you for your question. While the operational capabilities are not something that I feel I should comment on and I would like to leave to Navy, what I will say is that the submarine program, the Future Submarine Program I think that name is warranted because of the spiral development we have to inject new technologies and new capabilities as they become mature. So the first submarines developed will not be the same as ones delivered in future because of the very significant investment we've got for defence scientists and engineers working hand-in-hand with the Navy to help to bring on board those new technologies in that spiral development path. So that has been very deliberately crafted. I have a very significant number of staff that are working on this program and it is an ambitious technological plan and one that I think will give Australia a real edge. So they will be our future submarines. And while there may be constraints, we will make sure the very best science and engineering is there to go on board them.

SABRA LANE: Nic Stuart.

QUESTION: G'day. Nic Stuart from *The Canberra Times*. I'd like to take that in a slightly different way. I mean you talked about the role of physics particularly when you were a young girl, the way it revealed the world to you, the way you got excited by that. The same with maths. We've seen- you referred also to Carl von Clausewitz and the development that we've seen, you know there are particular trends that have developed in military that we've had since the turn of the century, the so-called revolution in military affairs. This has been looking at trends of miniaturization, lethality and greater radio remote control. Basically all of these trends, the sort of things that you're saying with physics, it's about revealing the world. That's the great drive. Now you've got submarines which are underwater. They're pretending they're going to hide and be able to hide this huge submarine that can't actually get away from anything. How on earth can you- and in fact one of your eight things – the STaR Shots - is specifically designed to reveal the world under the water.

TANYA MONRO: Correct.

QUESTION: How can we pretend that in perhaps ten years' time we might still have a workable submarine fleet but in 50 years' time, that we will possibly not have the ability of any possible potential adversary to actually reveal what's under the water? And given particularly that other nations are really developing their submarine fleets, shouldn't what we'd be doing is putting our money - we've only got a limited amount - putting it into the satellites and so on, revealing the water, going the way that that science wants us to and actually making things clearer rather than trying to hide?

TANYA MONRO: Thank you for a lovely rich physics question there. You have said yourself that one of our STaR Shots is underwater surveillance is about understanding that ocean environment and we have to, given the scale and nature of Australia's waters and for our local security. There are some laws of physics though that come into place about how and how much one can reveal. The ability to communicate underwater is limited by the laws of physics. So what we're doing is making sure we put appropriate investment into developing capabilities here in Australia that can ensure we have a lead in underwater surveillance. But at that same time that insurance policy of that long trusted and tested vehicle, the submarine. We need to be absolutely at the forefront of their development because our national security depends on it. So it's about that balancing portfolio risk and understanding that, while we may aspire to ubiquitous undersea surveillance, the laws of physics are likely to stop us at some point.

SABRA LANE: Misha Schubert.

QUESTION: Professor Monro, Misha Schubert, as a director of the National Press Club today, but also disclosing my role with Science and Technology Australia. I was really interested by your remarks around how to drive stronger collaboration between industry and publicly-funded research organisations and some of the things that you've done across DST to enable that. Can I invite you to perhaps offer a few thoughts about how we might do that a bit more broadly across that broader suite of industry and public research in the country? And if I may seek the indulgence of the president for a second question, I always like to ask people in very senior roles: what keeps you awake at night?

[Laughter]

TANYA MONRO: Thank you. So, I think the way we drive greater alignment between our knowledge engine in the country and the outcomes our country has is through fostering those deep partnerships between people who can use knowledge and people who create knowledge. I think, too long, we've seen them as enterprises that are separate. That

academics in ivory towers come up with ideas, some of which may be applied down the train. That model doesn't work. Now, I think the last decade, the journey the Australian university system has gone on to reflect on how you measure impact of knowledge creation has been a fabulous journey. In coming into a public research agency for the first time in this role, what I've learnt is that we play a really important pivot role where we connect the end user, whether that be industry or, in our case, the ADF, to that knowledge engine. And I think it's about just dissolving some of those boundaries and bringing those worlds together and valuing what impact the knowledge has, not purely its generation, which of course is important as well.

Now, what keeps me awake at night? Some of the challenges currently facing our university sector are very concerning. Because research is not fully funded, it does create challenges for us to sustain the world-class system that we have today. There's always that balance as well for an organisation like mine in fighting the fires of today and developing the game-changing, leap-ahead technologies we know we're going to need into the future. And I think the way we do it is shifting the emphasis, as we've done in this new More, Together strategy, to the problems, because what I've learnt through my whole career, and now in this role, is if you know the problem you're trying to solve, everyone is energised. And as we've shown in COVID-19 and bushfires, we can be fast. We can be agile. As well as doing things that may take a decade to pull off.

SABRA LANE: Can I segue off Misha's question, if you could, what would be the best advice that you would give a 20-year-old version of you?

TANYA MONRO: Yeah. To not let the idea that science is hard put you off. You'll be surrounded by people who, to you, seem much more able to do the things you're interested in. And that's just perception. That the best science is actually about asking questions, being bold, and being willing to be vulnerable and just saying: I don't know, and I want to learn. The 20-year-old me knew I wanted to be a physicist, and yet, I found there was a confidence gap between myself and, often, my male friends doing the same courses. So it'd just be not to question whether I could do it and take my passion for doing it as the confidence that I could.

SABRA LANE: Steve Lewis.

QUESTION: Thank you, Sabra. Steve Lewis, also director of the National Press Club. Late last year, the United States' Department of Defense released a really interesting research paper titled *Cyborg Soldier 2050: Human/Machine Fusion and the Implication for the Future for Defense*. Now, it wasn't an official document but, in that research document, the

authors, who were very, very senior research scientists involved with Defense, said: it's anticipated that specialised operators, such as Special Forces soldiers, military pilots, intelligence personnel, spies will be using neural implants for enhanced operation by 2030. Ten years from now. So, well before the future subs.

[Laughter]

Can I ask you, what work is DST doing in this space? We're talking about the fusion of human beings and machines. We're talking about brain implants. We're talking about enhancing soldiers, Special Forces, so that they have a better capability to go out and fight the enemy, whoever they might be. How much work is going on into this space within DST, if I may ask? And it raises massive ethical, moral questions. I mean, you're essentially talking about put chips, brains- chips or implants into the human body and sending them out to fight on behalf of Australia. It's a huge issue which 99.9 per cent of the population know nothing about. So can we have a bit of a chat…

TANYA MONRO: Sure.

QUESTION: …about what work DST is doing? Are we working with the Americans, our closest military ally? Are we working with other countries, such as the People's Republic of China, in this space? Thank you.

TANYA MONRO: Thank you for a very good question. So the first short response is that we are all over tech foresight in terms of understanding what directions technology could take that may impact our people. We put a lot of emphasis in our own research on human-machine teaming. It's about amplification of the effect of one human through the use of multiple autonomous platforms and systems, as I mentioned in our talk. Within DST Group itself, we don't have significant capability in the biological and medical sciences. In fact, in Australia, that is predominantly in our university sector. And we're increasingly partnering, but not in these particular contentious areas you talk about, largely around trying to do things like I mentioned in the speech: help our ADF know how to operate safely.

So I agree there are ethical and moral challenges with some of the potential future directions of technology, and we don't go down, in our own work, those pathways without a really clear policy protection and provision.

QUESTION: Just to clarify, we're not working in this space at the moment?

TANYA MONRO: No, we're not.

QUESTION: We're not going to- we're not developing technology that would allow Australian cyborg soldiers out into the field as early as 2030?

TANYA MONRO: No.

QUESTION: Thank you.

SABRA LANE: You've given us some insights into the work that you are doing, but surely there'd be quite a lot of research that's happening under your watch that falls into the category: I could tell you but I'd have to kill you. Do you think, if you're able disclose that, would it knock people's socks off? Like, what kind of research are we doing compared to around the world?

TANYA MONRO: Look, Sabra, the work our men and women do is extraordinary. Some of that we can talk about and some of it I've shared with you today, and some of it, for very good reasons of security, have to be classified in different ways and can't be more generally discussed. We work on some of these secure aspects with our trusted Five Eyes nations and colleagues because they have some of these shared challenges and we can help each other. A lot of the work that's done in this more secure classified environment is just as exciting, just as inspirational, as the work I can share with you, but there are very good reasons why there needs to be a layer of protection over that to keep Australia and its interests protected.

SABRA LANE: Tim Shaw.

QUESTION: Thanks Sabra. Professor, Tim Shaw, director of the National Press Club. Your address today was entitled *How the Science of Defence and the Defence Industry Impact the Australian Community*, and I think you've educated a lot of Australians that didn't even know what DST does. I've got a follow-on from Sara though. You've told us here today your work in relation to COVID-19. Can you specifically articulate the thoughts around the second and third waves of infection? We hear a lot from the PMO, from the Chief Medical Officer, from the COVID Commission. Can you tell us what your researchers have advised those departments and those individuals about what, when and how second and third waves of COVID could impact Australia and its defence?

TANYA MONRO: Look, thank you and I know this is a question that's preying on many of our minds as we start to ease restrictions. As I mentioned, our scientists, our experts contribute to that whole of government effort. There's not a separate standalone activity

that has different views. We provide models, we provide expertise, into that whole of government positioning and information. And I have to say I've been really impressed with how people have pulled together across different departments to do that. So, I don't have a separate view. We are comfortable that we are providing the right expertise into that whole of government decision-making. And thus far, I think the numbers tell the story. Now, will there be a second or even a third wave? Inevitably. Because the difficult decisions we have as a nation: do you keep borders closed forever? What effect does that have on our society, on our economy? But the question is: what are those trade-offs and when will our decision- our governments decide it's okay to gently turn on the tap? What the science does tell us – and this has been quite well communicated; the leading work came out of Imperial College in the UK – that probably the best management technique is a pulsed one, where you open the taps and then you start to close them again as the numbers go up just to make sure that the health system can cope.

The challenge for us is to make sure that we all understand that may happen, and that doesn't necessarily mean disaster or we've failed but that might be an appropriate management strategy. And that's comes to the heart of why we need people to have some understanding of STEM, of data of evidence. That's what the evidence tells us: that if we want to balance having a free and open economy and travel with health and the health systems' capacity, we may have to ease and tight restrictions over an extended period of time until we know there's a vaccine available.

SABRA LANE: Our final question is from Jon Millard.

QUESTION: Thank you Sabra. Jon Millard from *Inside Canberra*. Thank you Professor Monro for your [indistinct].

SABRA LANE: [Talks over] Come a little closer to the microphone please, Jon.

QUESTION: Since the invention of the gunpowder, most warfare has been concerned with hurling pieces of metal at each other, usually containing explosives. But at the realms of science fiction and many scientists [indistinct] have, do you think we'll ever get to the stage where a laser beam or a proton beam or, for that matter, some other sort of beam, neutron or whatever it might be, will ever be an actual form of attack?

TANYA MONRO: Thank you. Thank you. And I'm an avid reader of science fiction and there are certainly ideas they put in our minds. Look, I'm a laser physicist and there's no question that laser energy can have a direct, what we call, non-kinetic effect. There is no question that lasers today are extraordinarily powerful and can start to do some of the

things well beyond knocking out a sensor. That can be a real threat in war. So, I would absolutely say that non-kinetic warfare is in our future. But there are challenges in how we decide to counter such potential threats, also advantages in that Australia has great capabilities and understanding in the field of photonics.

SABRA LANE: On that note, ladies and gentlemen, please join me in thanking Professor Monro.

TANYA MONRO: Thank you.

[Applause]

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