Australian Government
Department of Defence

Professor Tanya Monro
Chief Defence Scientist
Ralph Slatyer Address on Science and Society
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# # #

Sabra—thank you for that kind introduction.

Firstly I would like to acknowledge that this is National Reconciliation Week and Reconciliation Australia has reminded us that whether in crisis or in reconciliation we are all in this together and it is important to show respect to Country, where ever we are.

Today, I wish to acknowledge the Traditional Owners of the land on which we are gathered, the Ngunnawal People. I pay my respects to their Elders, past and present.

I also pay my respects to Aboriginal and Torres Strait Islander men and women who have contributed to the defence of Australia in times of war and peace. I'd also like to recognize that Aboriginal and Torres Strait Islander people were some of the first scientists and inventors.

# # #

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 leading public servant and a former Prime Minister.

I am delighted and humbled to be the tenth speaker—to have the honour of seeing this annual event tick-over into double digits; to chaperone it into a new decade.

My sincere gratitude to Tony Peacock, Chief Executive Officer of the Cooperative Research Centres Association, for the invitation.

I would like to acknowledge the Association's staff and its Board of Directors—superbly led by Belinda Robinson.

Can I also thank the National Press Club, particularly Chief Executive Officer, Maurice Reilly, the management team, President Sabra Lane, and the Board of Directors.

I would like to extend a special welcome to Tony Slatyer, Ralph's son, thank you Tony for coming today.

To members of the press present, and Australians watching from home, thank you also.

# # #

Today, through the tradition of this annual address, we honour the memory and legacy of Professor Slatyer.

And while the face of the speaker may change year-on-year, our role remains the same: to reflect on science and society.

Science draws people together and harnesses ideas to solve some of the greatest challenges of our times.

Science has transformed our lives—taking us from nomadic tribes, to agrarian societies, to large, diverse communities connected on a global scale.

Science has lifted people out of poverty, cured diseases and put man on the moon.

Science gives us the tools to theorise, predict, observe and experiment. And in the process, we extend the limits of knowledge, develop new technologies and 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 earth and planets orbited the sun caused considerable theological consternation for centuries. It led to Galileo being placed under house arrest for life. And he was only formally cleared by the Vatican in 1992.

Einstein's utterly transformational general theory of relativity was criticized, and in fact, never did win him a Nobel prize.

And Darwin's notions of natural selection were deemed heretical by some.

We continue to be fascinated by science. It allows us to channel both our instinctive curiosity about our world and human creativity. It's the art of the possible, of what might be.

Science is not in itself 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."

At its heart, science is the search for truth and solutions.

And in doing so, humans are pulled together in a cooperative way to solve problems.

The collaborative nature of science is something Professor Slatyer understood well.

It is why he championed the concept for Australia's world-renowned Cooperative Research Centres.

Professor Slatyer was ahead of his time.

He appreciated that the increasingly complex challenges of the future would require the distinct strengths and capabilities of academia, industry and government to be brought together.

I contend that Defence Science is doing just that—bringing together interdisciplinary expertise from across the nation to undertake mission-directed research to solve some of Australia's most pressing problems.

So, to honour this event's tradition of reflecting on science and society, today, I would like to explore Defence Science within an Australian context.

# # #

But first, a few words on Professor Slatyer.

Ralph had initially been appointed by Prime Minister Malcolm Fraser as Chairman of the Australian Science and Technology Council—or 'ASTEC'.

This part-time position was essentially the Prime Minister's science adviser.

When Bob Hawke's Labor Party came to power, the new Prime Minister agreed for Ralph to stay on in the position.

Hawke wanted to have an adviser 'on tap' in a full-time position; and to establish a Prime Minister's Science Council and Coordination Committee on Science and Technology.

18 months after Ralph finished his Chairmanship of ASTEC, he accepted the job of the newly created position of Australia's Chief Scientist—a role Dr Alan Finkel performs so capably today.

The Chief Scientist provides independent scientific advice to the Prime Minister and other senior ministers.

They champion Australian science internationally and promote an understanding of science among Australians.

It is fair to say it's a tough gig.

Ralph did it masterfully, with discernment and poise.

# # #

A small part of Ralph's legacy was that he set me on my career trajectory.

As I mentioned, one of Ralph's many contributions was the establishment of the Cooperative Research Centre program.

One of the early Centres was dedicated to Photonics. Specifically, it examined new ways to use light to improve telecommunications.

As a student, I was excited by physics. I was intrigued by the study of energy and forces, of nature and the universe, of space and time.

But I needed it to be real; I yearned to link intellectual inquiry with something tangible.

Luckily, that opportunity came to fruition in the form of a PhD with the Photonics Cooperative Research Centre in Sydney—a CRC formed in the very first round of the CRC scheme.

This experience was a revelation; an awakening: I found myself in a vibrant environment in which young research scientists worked directly with industry engineers; where new ideas could be rapidly translated into outcomes.

Soon after, my PhD landed me in the United Kingdom. I joined a team at the University of Southampton which had all but invented optical fibre technologies.

Like veins and arteries which carry blood to and from the heart, these optical fibres would become the internet's circulatory system—carrying vast amounts of data back and forward across the oceans.

And we must have been doing something right. Because every week, industry was knocking on our door.

Equipped with this experience, I returned to Australia to take up an opportunity at the University of Adelaide to work in partnership with the Defence Science and Technology Organisation—as it was known then.

My task was to establish a photonics centre focused on research in new classes of lasers, new optical materials and novel optical fibres and sensors. I took an interdisciplinary approach, recognising that the real-world challenges we face don't respect the boundaries in which we conventionally organise our sciences.

One of the earliest projects Defence proposed was to detect corrosion within aircraft using light. Work over a decade on this practical but challenging problem led to

some surprising and exciting new discoveries—and the development of water quality sensors, virus diagnostics and smart IVF machines.

Perhaps most importantly, coming from Adelaide, we discovered how to monitor the maturation of wine inside a barrel!

Through all of this, I have learned that when researchers work hand-in-hand with the end-users of that research, two things happen.

First, an insight into the problem they need to solve inspires new research ideas.

And secondly, familiarity with the science itself helps the end-user make use of the outcomes.

In Defence Science, it is imperative that our primary focus is always on the customer and end user—in our case, the Australian Defence Force and meeting the needs of our nation.

Be that related to defence capability or providing assistance domestically, such as in the current COVID-19 environment, or responding to bushfires.

# # #

Defence Science in Australia—as an institution and practice—is 113 years old.

In fact, we recently celebrated the 80th birthday of our Fishermens Bend site in the busy industrial district of Port Melbourne.

With over two thousand staff across the country, we are Australia's second largest national science agency.

Last year, I had the 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 the defence and national security needs of our nation.

In so doing, we are helping the Australian Defence Force defend Australia and its national interests.

In the past, a nation's ability to defend its interests, deter its adversaries and defeat its opponents was largely determined by a count of aircraft, warships and boots on the ground.

As observed by the Napoleonic-era Prussian strategist, Carl von Clausewitz, military advantage was about mass, weight and a concentration of force.

However, today's technological developments and the world's hyper-connectivity are transforming the characteristics of warfare.

The deterrence once afforded by distance has given way to the perils of proximity.

Nations and non-state actors are employing cyber-attacks and other elements of hybrid warfare which exploit the grey area between peace and war.

And the emergence of new capabilities—like hypersonic weapons, high-speed and long-range missiles, and artificial intelligence—is increasingly challenging traditional military capabilities.

All this is playing out globally, but especially in a multipolar, dynamic and complex Indo-Pacific region.

Today, military advantage is contingent on information and intelligence, speed and networks, and preparedness and adaptability.

To prevail in a contested environment, Australia needs a modern military force equipped for modern warfare.

I would contend that the role of Defence Science and Technology, in the defence of our nation is today more important than ever.

It's a mission we cannot do alone; rather, one that requires us to draw on the best minds and ideas of the nation.

# # #

So, with that context in mind, let me tell you about some of our work:

We have extended Australia's horizons.

The Jindalee Operational Radar Network—or 'JORN'—consists of three over-the-horizon radar systems.

These electronic sentries surveil Australia's northern sea and air approaches, scanning out to a distance of between 1,000 to 3,000 kilometres.

Defence Science started researching JORN technology in the 1970s. And it began operations nearly 20 years ago.

Unlike traditional radars that are limited by the line of sight, the JORN system uses the ionosphere above the Earth's surface, to bounce high-frequency radio signals to track targets in real-time.

Our scientists have partnered with a team from the University of Adelaide which has developed a cryogenic sapphire clock, which is so precise, it gains or loses only one second over 40 million years.

This unparalleled precision should guarantee that future upgrades to the JORN system will allow us to continue to lead the world in this technology.

# # #

Turning to our air capability, which is crucial for the defence of Australia.

The 2016 Defence White Paper made the case for delivering 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 take to the skies?

If we retire an aircraft too early, it costs money and we jeopardise capability.

If we retire an aircraft too late, it could endanger lives.

What is the 'Goldilocks zone'?

Well, in 1949, one of our scientific engineers wrote a paper—*The Life of Aircraft Structures*.

His colleagues subsequently tested 222 Mustang fighter wings and wrote a manual on aircraft fatigue.

Both these scientific publications gave birth to expertise which has enabled our aircraft to fly further, be safer and have their service-lives extended by many years.

Since that time, we have saved the Australian taxpayer tens of billions of dollars, supporting the safe extension of life and operation of the F1-11s, the F/A-18 Hornets, Hercules, and Orions and other aircraft.

Today, we are using these same principles to assess our latest jets—the F-35 Joint Strike Fighter—so that the nation gets the most from the world's most sophisticated stealth fighter.

# # #

And what about protecting our troops?

Every day, Australian soldiers use metrics developed by Defence Science to reduce the risk of injury or death from heat stress.

And when our soldiers are on active duty in Bushmaster Armoured Mobility Vehicles, these four wheeled drives may soon be protected from explosives by—wait for it—water.

An armoured vehicle on patrol carries hundreds of litres of water, so our engineers popped to Bunnings, bought some jerry cans and tested what happens in an explosion. They demonstrated that if you position water in the right places, the water absorbs the energy of the explosion and can help protect its crew.

Who would have thought that water could serve as an alternative form of armour?

There's something quintessentially Australian about that discovery.

# # #

Defence's confidence in the CRC model established by Professor Slatyer is demonstrated through our support of the first Defence Cooperative Research Centre in Trusted Autonomous Systems.

The Centre was established under the Defence Next Generation Technologies Fund, with $50 million dollars being invested over seven years.

The Centre has brought together industry and researchers to develop the next generation of world-leading, smart-machine technologies based on advanced human-machine teaming.

# # #

So, where are we heading?

History shows us that predicting the future is a difficult endeavour which we don't always get right.

Less than eight years after the Wright Brothers successfully piloted the first self-powered airplane, Ferdinand Foch, the French general and military theorist, declared that while airplanes were 'interesting scientific toys', they are of 'no military value.'

He would later become the Supreme Allied Commander during the First World War.

And in my own field, photonics, when the laser was first invented in 1960, it was labelled purely a scientific curiosity. I don't think any of us could get through a day without having laser light do our bidding as we search the web or purchase groceries at the check-out.

But in Defence, our responsibilities require us to make predictions and to explore how technologies might advance into the future.

So we continually assess and reassess the strategic environment; we make forecasts on technological developments—which we call 'tech road-mapping'.

Importantly, we do all these things to anticipate challenges to the nation, and ensure we are prepared for future challenges.

Australia's military is a modestly sized defence force in globally-comparative terms.

But 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; 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 enhance our future capability?

Earlier this month, Minister Reynolds launched our new Defence Science and Technology Strategy 2030: called 'More, together'.

Traditionally, a lot of Australia's research is driven from the ground up. This new strategy seeks to invert that process.

The core concept of the strategy is to establish 'missions' that focus and align Australia's science and technology research efforts to develop capabilities which address some of our nation's biggest problems.

We have named the missions 'Science, Technology and Research Shots'—or 'STaR Shots'.

The STaR Shots are aspirational and inspirational goals. They have been devised to unlock the creativity of the nation and to shape our research and development system to set the foundation for leap-ahead sovereign capabilities.

And for STaR Shots to be successful, we must harness research expertise from across the country—that is, people working in our universities, industry and our publicly-funded research agencies.

# # #

Let me give you some examples:

Many of you would remember the scenes from World War One and Two films where generals would synchronise their watches before an attack.

Today, our combat forces rely on the US GPS system.

We use that system for precision guided weapons and to coordinate and synchronise distributed forces. The timing aspects from this system are used in communications, cryptography, to timestamp intelligence, and to synchronise distributed computer systems.

When that's under threat due to a conflict, we don't really have an alternative.

Another problem with GPS is that it doesn't work in all environments. It typically won't work underground, underwater or sometimes in complex urban environments.

So the real challenge is what we do if we lose our GPS?

The Quantum Assured Position, Navigation, Timing STaR Shot is being developed from what we sometimes refer to as, the 'second quantum revolution'.

This is looking to produce unprecedented sensitivity in sensors through things like gravity meters, accelerometers, magnetometers and precision clocks.

It's expected that these sorts of things will provide the ability to generate an alternative assured positioning, navigation and timing solution.

But Defence cannot do this alone. Connecting with industry and academia is absolutely fundamental. And the reason for that is Australia has world-leading capabilities in both academia and in industry in quantum technologies.

We have also established a program with our colleagues in the UK, US, Canada and New Zealand, where we will bring these various capabilities together, and put them onto a New Zealand frigate in 2024 and experiment to see what works and what doesn't.

What will be the outcome be of this in 10 years?

We will have an alternative to the existing GPS system that will operate in contested environments and deliver that assured positioning, navigation and timing capability that our nation needs.

There is a fabulous opportunity to bring together world-leading capability that Australia is already developing, to apply it to a practical problem where, in time, that will likely save Australian lives.

# # #

And what about space?

In November 2019, NATO formally declared space as an 'operational domain'.

Space provides important capability for Defence. We use it for communications, for position, navigation and timing, and to get earth observation products.

But space is changing. As well as becoming more contested; it's also becoming more congested.

Those traditional satellite capabilities we rely on are becoming challenged and new technology is needed to overcome this.

Enter the Space STaR Shot, which seeks to develop a resilient smart satellite network to enable the ADF to access data direct to wherever they are on the planet.

To achieve that goal, we have to create a lot of autonomous technology that works in space.

We will also put technology in space to manage congestion by automatically maneuvering to remain safe.

Defence Science has an embryonic space capability. We have been building satellites; we have launched one successfully; and we have another launch coming soon.

But we are seeking to create a sovereign industrial capability to provide increased space capability for Australia. And to do that, we need to partner with great minds across our nation and internationally.

That is why Defence Science has invested $12 million dollars in the SmartSat Cooperative Research Centre, which has attracted an investment of over $250 million dollars from over 100 Universities, industry and government organisations.

This is the largest investment in Australian space industry in our history.

And importantly, these resilient clouds of small, smart satellites will have wider application beyond defence.

They will help us manage the quality and quantity of water resources across the country.

They will help farmers and miners precisely control heavy machinery from hundreds or thousands of kilometres away.

And they will support emergency services when conventional communications are overloaded in a crisis.

Through the STaR Shot, we are also partnering with Australia's Space Agency which was formally opened by the Prime Minister in February this year, which will also assist in building new space infrastructure to support our space aspirations.

All of these activities mean that it is an exciting time to be interested in space.

Indeed we are working to inspire the next generation of young Australians to become involved in STEM.

# # #

These are 2 of our 8 STaRShots. We've just selected the leaders who will work with our industry and academic partners to plan and develop the research activities that will deliver on these aspirations, please go to our website for more information.

Having ruminated on the future of Defence Science, let me return to the present.

Most recently, we have aided Defence's response to support the front line services during the horrendous 2019-20 bushfire season and the COVID-19 pandemic.

As homes and lives were lost in the fires, Australians would have seen the camouflage uniforms of the Australian Defence Force supporting and assisting our colleagues in the orange and yellow attire, the firefighters and state emergency services.

At the peak of Operation Bushfire Assist, more than 6,500 servicemen and women—including about 3,000 Reservists—supported relief, response and recovery efforts across five states and territories.

What Australians may not have appreciated was that Defence Science was also playing a part.

Over the Kangaroo Island and Gippsland fires, a Defence Experimentation Airborne Platform aircraft was undertaking missions using the country's most sophisticated sensors and cameras.

Flying above the burning landscape, the crew were using the aircraft's equipment to look through the smoke and provide information on fire intensity, movement and damage to other fire-fighting aircraft and ground emergency responders.

We also demonstrated the ability to detect new spot fires from a distance.

This will help us respond to future bushfire seasons.

# # #

From the bushfire season to the COVID pandemic.

Each year Defence Science helps model and predict the scale of influenza infections to support medical planning.

And it is this experience which has seen us make important contributions as part of the national response to the COVID-19 pandemic.

We contribute to COVID-19 modelling provided to the Australian Health Protection Principal Committee.

Similarly, working with the University of Melbourne and University of Adelaide, we have developed forecasting on the transmissibility and severity of COVID-19 within Australian households.

We are also collaborating with CSIRO to determine how well the COVID-19 virus survives on banknotes and other surfaces.

In late March, we established a rapid-response group to help increase domestic stocks of invasive ventilators.

Simply put, invasive ventilation is the use of a tube to support patients who are critically ill and can no longer breathe on their own.

Within a space of 3 weeks, our engineers designed a device which can convert existing non-invasive ventilators to perform as invasive ventilators.

This involved fast failing a number of prototypes and testing their safety in partnership with university researchers and medical professionals.

And this device now stands ready to be rapidly manufactured should the need arise within Australia or to assist neighbouring nations in our region.

Defence Science also established a partnership with the family-owned South Australian business, Axiom Precision Manufacturing, to produce face-shields for frontline healthcare workers.

Defence designed and prototyped the face-shields using 3D printing and Axiom is now mass producing them using injection moulding.

The first batch of 600 face-shields went to South Australian hospitals in April for evaluation. They're cheaper than imported face-shields and, I'm told more comfortable.

A further 4,000 face-shields are now being produced.

These are just a handful of the ways Defence is working across industry and academia to deliver a positive impact for Australians.

# # #

Ladies and gentlemen,

When I reflect on Defence Science, I am excited about the role we will play in shaping Australia's future, and the relationships we are fostering.

We are partnering with all 37 public universities in Australia under our new Defence Science Partnerships agreement.

We are deepening our partnerships with the other publicly funded research agencies and independent associations such as CSIRO, the Bureau of Meteorology, ANSTO. Australian Academy of Science and the Australian Academy of Technology and Science.

We currently have 12 strategic industry alliances with major defence primes.

We work with multiple Cooperative Research Centres, and have strategic collaboration agreements with a range of small to medium enterprises.

As Defence Science and its partners continue to work collaboratively in a mission orientated way to deliver the capabilities that Australia needs, we will grow the alignment of Australia's research to our priority challenges.

Our research and development will provide our country with powerful new technologies that we will find clever, and at times unanticipated uses, in health, agriculture, mining, and environmental protection.

It will also build new capabilities in research and industry; create new, high value jobs in science, technology, engineering and maths for women and men.

And I acknowledge the Prime Minister's remarks at the Press Club yesterday: about building on our world-leading strengths; about the important role research and science will play in setting-up Australia for economic success over the coming years.

Defence Science will give our service men and women a capability advantage so that they can prevail in a contested environment.

Is Australia up to the challenge in this rapidly changing world full of uncertainties?

Absolutely. We have the expertise, the ingenuity, the passion and the character to pull this off.

I'm sure Professor Slatyer would agree.

Thank you very much.

[ENDS]