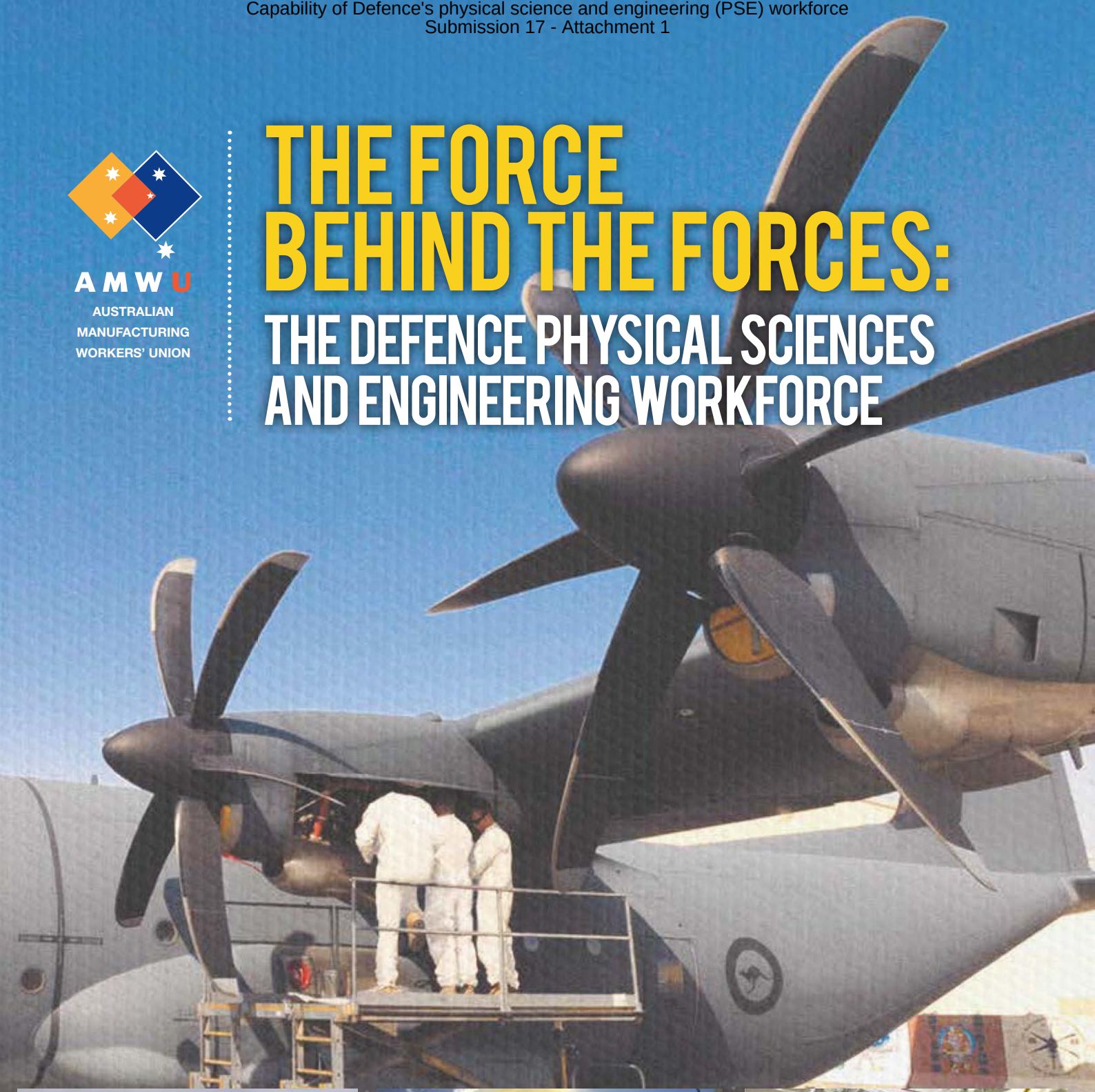
AMWU
AUSTRALIAN MANUFACTURING WORKERS' UNION

THE FORCE BEHIND THE FORCES:

THE DEFENCE PHYSICAL SCIENCES AND ENGINEERING WORKFORCE



FOREWORD

This document underpins a national awareness campaign about the importance of the tradespeople and technicians in the Defence industry, particularly within the Department of Defence.

It considers the trade and technician workforce employed by the Department of Defence, such as those working within the Army, Navy and Air Force as well as the Defence Materiel Organisation. In addition to the 'top of mind' Defence Physical Sciences and Engineering (PSE) workforce who work on the acquisition and sustainment of military equipment, the workforce comprises elements of the Defence Science and Technology Organisation (DSTO), and lesser-considered Defence elements such as the Australian Geospatial Intelligence Organisation.

This document emphasises the value of the Defence Physical Sciences and Engineering workforce, both in their day to day contribution to Defence outcomes, and their importance as a means of demonstrating that Australia is a worthy custodian of the military technologies entrusted to us by our allies.

The importance of a viable and sustainable Defence workforce, as the people responsible for representing government interests in relation to delivering the best value outcome for the Australian Defence Force, and for the Australian taxpayer is something that cannot be over-stated.

As is the case for many government institutions, the ability to act as an independent and informed procurer of goods and services, with a genuine ability to assess value in terms of cost, risk and performance, is lost in the background noise of bureaucratic process and beltway banditry.[1]

Unlike commercial undertakings, the defence of Australia and its national interests cannot be deferred until more favourable conditions make it economically viable. It is not a capability that can be realistically outsourced, nor can it be quickly ramped up by throwing money at the problem.

Regardless of the shape, size and composition of the future Australian Defence industry, and the way in which products and services are delivered to the marketplace, the need to have sufficient organic capability to produce, at the very least, the bare minimum acceptable level of compliance and accountability required by government is inescapable.

In relation to Defence equipment and systems, determination of value must always include the cost of building an enduring workforce to meet the support needs of a platform, system, or piece of equipment over its entire life cycle. For Defence, product life cycles can be upwards of 30 years or more, which far out-stretches life expectancies of mining and energy equipment, systems and methods.

On the other hand, the specialist nature of military technology means that demand for people with the skills, knowledge, experience and security clearances to work in the leading edge environment is problematic – whilst demand for a specific skill may be limited to one or two positions, the effect of not having the workforce available when needed could render an entire system useless. Depending on the circumstances, this could place the lives of Australian Defence Force members at risk.

1. *The term 'Beltway Bandit' originated in the late 1960s, and is used to describe private companies located on the Capital Beltway, the ring road that surrounds Washington D.C. These companies tend to employ former senior Defence officials to access, or influence, key project decisions in their favour.*

2 *Thomson, P. http://www.smh.com.au/national/public-service/fears-for-adf-because-of-concerns-over-defence-materiel-organisation-workforce-20141116-11mvbg.html , 16 November 2014. The article includes results of a leaked 23June 2014 audit into DMO, stating that the DMO had no strategy to attract the correct engineering and technical skills in the future and had no idea of the skills gaps in the organisation which could lead to the ADF being put at risk.*

The limited demand for deep specialisation reduces the scale and scope of supply 'feeder' lines, meaning that there will be occasions when retention is a matter of strategic criticality rather than economic rationality. Regrettably, investment in retention is viewed through the lens that suggests that 'no individual is indispensable', rather than the one that advises that 'it is cheaper to keep knowledge and experience than it is to buy it or grow it again'. Withdrawal of investment in training and education is a short-term fix with an instant positive dollar boost to a budget bottom line, but it is a false economy. Failure to ensure an appropriate level of competence exists throughout the Physical Sciences and Engineering workforce increases the risk of compromising the Defence technical regulatory framework, as a June 2014 audit into DMO suggested.[2]

Whilst some work has been done in relation to critical occupations, aggregation of functions at the Group level obscures pockets of criticality dotted throughout the workforce. In the case of highly specialist areas, the small number of people under consideration are swamped by a preoccupation with placating louder, larger and less expensive groups competing for the same portfolio dollar. Greater investment in meaningful analysis of critical occupations in terms of outcome value added, as opposed to inward accountability chains, may be a step in the right direction.

In the case of weapons and equipment sourced from overseas, a failure to demonstrate adequate investment in the human resources to manage these systems runs the risk of Australia losing its status as a trusted custodian of the most advanced technologies available, consigning us to the 'second eleven' of middle powers, and affecting our ability to be considered as a serious player in global affairs.

The dilemma is that unless the Australian Defence Organisation has a sustainable workforce consisting of sufficient Physical Sciences and Engineering workers at the appropriate levels of knowledge and ability, it risks slipping down the ladder of international relevance and into obscurity.

Whether it be the family car, or a multi-million dollar warship, the cost of owning a capability increases with age; investment in maintenance and repair increases as does the cost of those that maintain its functionality. Understanding the true cost of ownership of an asset is the key to making good decisions, based on sound judgement, resulting from knowledge, experience and skills, and is the bread and butter of the Defence Physical Sciences and Engineering workforce – so that when the time comes to replace 'old faithful' with a new model, it is based on sound advice from a trusted, knowledgeable and independent source, rather than leaving it to chance, price, or a combination of both.

Paul Bastian
National Secretary
Australian Manufacturing Workers' Union

KEY MESSAGES

THE KEY MESSAGES OF THIS DOCUMENT ARE AS FOLLOWS:

- The Australian Defence Force (ADF) is reliant upon high technology embedded in sophisticated military equipment including warships, aircraft, armoured vehicles, electronic systems and weapons. It must be able to support the equipment throughout its lifecycle, which can be extremely long. Australia must have the know-how to build some of this equipment and repair/maintain all of it. If not, it faces the prospect of sourcing repair expertise from overseas or adopting a repair by replacement philosophy, both of which are prohibitively expensive.

- The workforce with the necessary skills, knowledge and experience to specify, build, maintain, repair, oversee and assure the work required comes from both Defence and industry; they have distinct roles that must be balanced and work in harmony.

- The people in the Defence Physical Sciences and Engineering workforce encompass a broad range of trades and technical disciplines. The nature of military equipment means that it exists at the leading and bleeding edges of technology[3], demanding strict attention from those who work with, and in support of, ensuring systems, equipment, products and procedures are safe, fit for purpose, and environmentally compliant.

- People of the Physical Sciences and Engineering workforce make decisions every day that affect the safety of everyone in the Defence environment; through their oversight and specification work, they assure the safety of the workforce that manufactures and maintains defence equipment, and the safety of the soldiers, sailors, pilots and air crew who operate it.

- People of the Defence Physical Sciences and Engineering workforce make decisions that are critical to readiness of military equipment in service; from the provision of Statements Of Work, Functional Performance Specifications and Quality Acceptance Criteria, to writing safety procedures and conducting physical tests on equipment, systems, weapons and ammunition, all of which contribute to ensuring the purchase of the right equipment for Australia.

- The people of the Defence Physical Sciences and Engineering workforce are responsible for ensuring that locally manufactured equipment is built to the right standards through observation, measurement, assessment, testing and witnessing of the design, build, installation and commissioning phases of Defence projects. They are also responsible for delivering these services to the Army, Navy, and Air Force for the sustainment of ships, aircraft, systems and equipment once the materiel enters service.

- The Defence Physical Sciences and Engineering workforce contributes to the delivery of effective combat power in ways that go unseen by all but the most astute. From the conduct of tests on ammunition delivered to our forces overseas, to the inspection of missiles and munitions used by our Air Force in the skies over the Middle East, the Physical Sciences and Engineering workforce is involved. From the determination of concussion effects from ordnance on ADF vehicles to their assessment as safe, operable and reliable in the harshest climates, the technicians and engineers are 'front and centre'. The work is demanding, the standards exacting and the results are critical to ensuring the difficult and dangerous work of the Australian Defence Force is being done at the lowest possible intrinsic risk imaginable.

- The quality of the decisions made by the people of the Physical Sciences and Engineering workforce has a direct impact on Defence's performance, with bad decisions resulting in poor readiness, unreliability and higher costs, and good decisions resulting in high readiness, effectiveness and lower costs.

- Defence industry in general, and the Department of Defence in particular, are facing immense challenges to sustain a viable and vibrant workforce. The war for technical talent and technologically savvy workers pits Defence against competition with shorter planning timeframes and deeper pockets. This means that despite the magnitude of Defence contracts, there are more attractive, lucrative and lower risk opportunities available.

- Australia needs a Defence Physical Sciences and Engineering workforce as an enabler of Defence Industry. Realistically, Defence can only sustain this workforce in competition with industry if remuneration attracts good young people and retains older, experienced people. Well-planned training, mentoring and education programs that develop skills and knowledge, properly structured technical workstreams, and an organisation that both supports viable career paths, and is prepared to properly resource them through 'boom' and 'bust' is what is needed to support the workforce supporting our soldiers, sailors, pilots and air crew – the force behind the Forces.

3 In this context, 'leading edge' refers to high technology, high risk, high cost activities of limited commercial return (other than the military context) such as high speed intercept radars and precision munitions – some would argue research and intelligence collection would also fall here. 'Bleeding edge' refers to activities that are low technology, high cost, such as is required to maintain older generation military equipment, which demands a comparatively high skilled labour content, generating issues in relation to commercial viability.

SECTION 1
DEFENDING AUSTRALIA: A UNIFORM INVESTMENT

"An investment in knowledge always pays the best interest."[4] (Benjamin Franklin, 1758)

The Defence of Australia and its national interests is a massive undertaking, consuming roughly 1.6 percent of our Gross Domestic Product[5]. The Physical Sciences and Engineering communities both within and external to the Department of Defence are deeply involved, providing the majority of research, analysis, and execution activities associated with military equipment, systems, processes, products and services.

Defence Industry represents a sizeable portion of Australia's manufacturing sector, ranging from fundamental heavy manufacture, repair and maintenance to the adaptation of cutting edge technologies to Defence purposes. Behind the technologies and systems remains the fundamental unit of labour that Adam Smith described over 200 years ago, as follows:

"The annual labour of every nation is regulated by two different circumstances - first, by the skill, dexterity, and judgment with which its labour is generally applied; and secondly, by the proportion between the number of those who are employed in useful labour, and that of those who are not." [6]

Whilst economic theory has changed over the years, the fundamentals remain as important today as they were when James Cook set sail for Hawaii – skill, dexterity, and judgement: people doing useful work adding maximum value to the economy to support the collective needs of the community at large.

Whether it be inside the Defence portfolio, or delivering products to it, the specialist knowledge, skills, and specific experience of the members of these different, but linked communities combine to deliver intellectual infrastructure and value-adding products to Australia. Equally, in order to ensure quality supplies are produced, and the quality of the supplies can be properly assessed, we must ensure both sides of the Physical Sciences and Engineering ledgers balance – namely, both workforces deliver skilled, knowledgeable, capable and competent capability.

"Intellectual capital is the most valuable of all factors of production." (Brian Tracy, 2012)

According to the National Commission of Audit: "Defence spending constitutes a significant part of the Commonwealth Budget. At $25.3 billion, it represents around 6 per cent of all Commonwealth expenditure. The Commission considers that the starting proposition for Defence funding should be to determine the defence capability required to successfully counter the various strategic risks Australia could face and then match this with appropriate funding to address the highest priority ones."[7]

In dollar terms, Defence, through the Defence Materiel Organisation, expends around $12 billion annually on procurement and sustainment activities.[8] The high value of Defence acquisition projects results in impressive spends, but can also generate spectacular failures; at a time where economic prudence is increasingly expected when it comes to Government expenditure, the need to have solid performers with exceptional judgement and a track record of robust decision-making is paramount.

Good judgement comes from deep specialist knowledge of subject material, an understanding of the technical and technological cost drivers, and experience in managing complex systems and projects - the ability to make good decisions grows from this base, and this is where true value is realised. A key theme in this document that will be emphasised is that unlike commercial undertakings, Defence can neither wait for a problem to happen before attempting to fix it, nor can it leave capability underground until it's more profitable to dig it up.

Since the Global Financial Crisis, the value of skills, dexterity and judgement, particularly in relation to the engineering and technological workforces has increased, as have the costs of acquiring them. The GFC drove companies to make survival-based decisions with respect to who stayed and went, what was kept, and what withered. Neither Defence, nor Defence industry can compete with the mining and energy sectors, who, in the light of a reinvigorated resources sector are prepared to pay a premium for the people they need today, regardless of the investment made elsewhere in producing them. As demand further outstrips supply, the gap widens, and the ability to sustain a viable Defence technical workforce wanes. Sooner or later the system will collapse, unless serious effort is made to ensure critical intellectual infrastructure is valued, nurtured and retained.

A recent industry study described the global shortage of engineers and engineering-related skills as follows: "As global economies struggle to regain their financial footing following years of economic turmoil, many companies worldwide are dealing with a shortage of qualified engineers to fill positions necessary to win the big contracts that can get their businesses back on track. Government leaders are concerned too, as they recognize that economic success in today's world requires their respective nations to become leaders in innovation in science and technology. According to a study conducted by Manpower Group, which surveyed more than 38,000 companies in 41 countries, engineers ranked number-two among the hardest jobs for employers to fill in 2012 worldwide, up from number four in 2011."[9]

"We have to have that sovereign engineering capability, and the most cost effective way to achieve that is to build them here in Australia." (Australian Government Senator, 2014)

Skills, dexterity and judgement are the pillars that support good decisions. In terms of maintaining the capacity to defend Australia and its national interests, good decisions are vital. As members of the community at large, we expect our Defence Force to have the kit they need to go about their business efficiently, effectively and with a minimum of fuss – just as they always have. As taxpayers, we want our dollars to give the ADF the best possible 'bang for the buck'; and as parents, friends, and family members, we want to ensure the people of the ADF are as safe as possible, by ensuring our Defence Physical Science and Engineering community is the best it can be.

4 *Franklin,B., The Way to Wealth: Ben Franklin on Money and Success, 1758*
5 *Stockholm International Peace Research Institute (SIPRI), Yearbook: Armaments, Disarmament and International Security 2013.*
6 *Smith, A., An Inquiry into the Nature and Causes of The Wealth of Nations, 1776*
7 *Australian Government, Report of the National Commission of Audit 2013 Part B, Chapter 7.8*
8 *Defence Portfolio and Budget Statements (DMO) 2014-15, p.141.*
9 *http://creo.ptc.com/2013/03/18/governments-industry-and-universities-respond-to-global-shortage-of-engineers/#sthash.8oPcFlrX.dpuf*

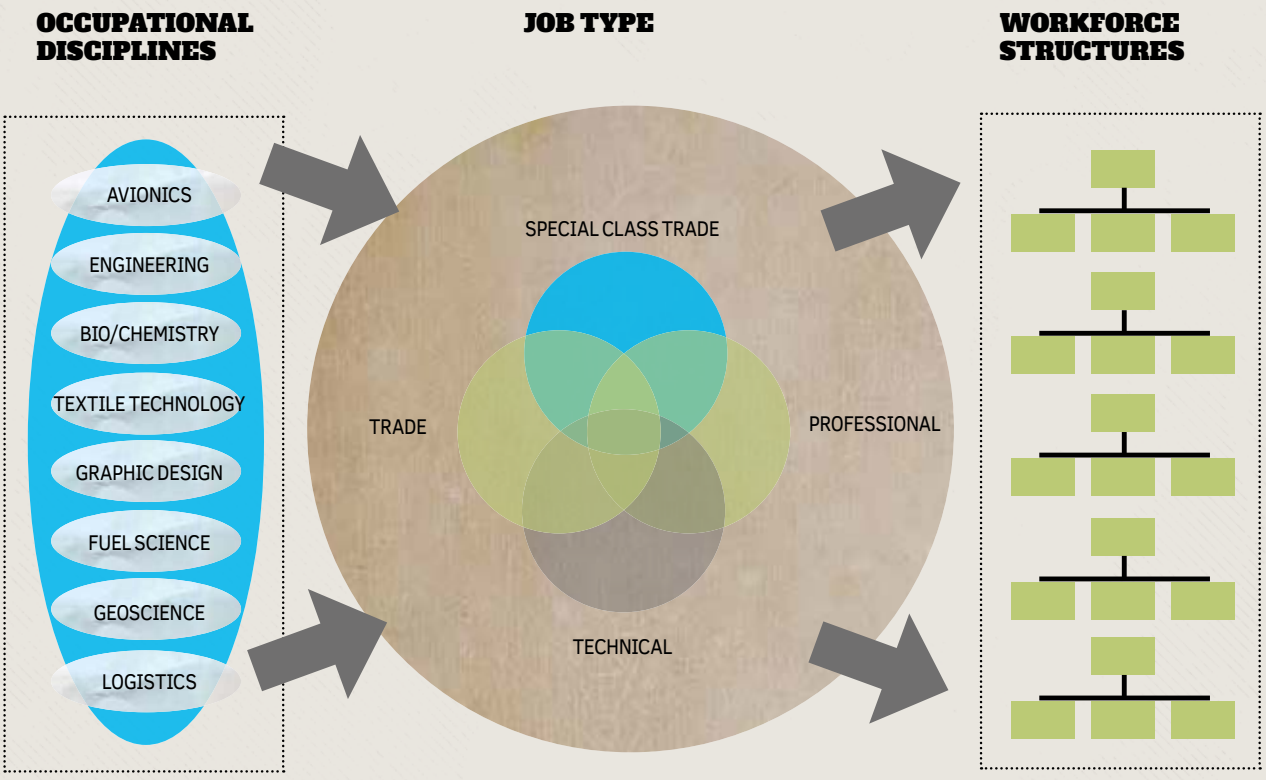
The Physical Science and Engineering employment stream incorporates:

> Air Traffic Control, Avionics, Bio/Chemistry... Engineering, Fuel Science, Geoscience, Graphic Design, Land Surveying, Logistics, Marine Surveying, Metallurgy, Meteorology, Naval Architecture, Oceanography, Petroleum Technology, Pharmacy, Physics, Surveying and Textile Technology.[10]

Such work is performed by, amongst others, technical, trade, and professional employee groups, each of which is defined in part by the levels reached against the Australian Qualifications Framework (AQF). The combination of occupational discipline and type of employee feeds into workforce structures, as shown on Figure 1.

FIGURE 1

The Physical Sciences and Engineering Workforce Stream as it relates to job types and workforce structures.



10 *Defence Classification Manual (DCM), available at www.defence.gov.au/dpe/pac/aps/workstandards_home.htm, p 28*

SECTION 2
THE COMPLEXITY OF MODERN MILITARY EQUIPMENT AND ITS SUPPORT NEEDS

"It is possible to fly without motors, but not without knowledge and skill." (Wilbur Wright, 1910)

The Australian Defence Force is reliant upon high technology embedded in sophisticated military equipment including warships, aircraft, armoured vehicles, electronic systems and weapons.

To safeguard national security, Australia needs an industry capable of designing, manufacturing, testing and integrating a variety of military equipment, and being able to maintain, modify and adapt it to suit our unique environment. For the industry to be effective, there must be a balance of high quality commercial interest and government facilitation, so that there is enough industrial capacity to produce the materiel required, and enough intellectual infrastructure to transfer the Defence Capability Plan into specifications, tenders and projects that deliver equipment, systems and support to the ADF.

The inter-generational leap in military technology means that Australia runs the risk of falling behind its allies and neighbours if it fails to maintain a viable Defence organisation. In particular, the work of the Defence Science and Technology Organisation (DSTO), through its 2,500-strong workforce of predominantly scientists, engineers, technicians and IT specialists, leverages key relationships with the global military scientific community and ensures Australia remains a trustee of leading edge technologies. Without a viable Physical Sciences and Engineering workforce, DSTO would be unable to deliver programs to support and protect critical national information infrastructure, enhance abilities to detect, locate, classify, identify and track targets and activities of interest[11], and work in key research areas such as hypersonics, which was recently described by the US Air Force Chief of Staff as a breakthrough that "will have a profound impact that can revolutionise the way we approach our core missions in the future – from investments, to force posture, to tactics, techniques, and procedures - and though we may not always desire to operate at the fastest possible speed, the ability to do so creates a significant advantage." [12]

In terms of military hardware, perhaps the best way to tell the story about the sort of technology that is installed in ADF equipment is to tell it by the numbers – in this case, comparing the C130 Hercules with the C-17 Globemaster.

GLOBEMASTER C-17
Entered Service in Australia: 2006
Cost per unit: $205m AUD
6 aircraft delivered to Australia
34 aircraft delivered around the world outside of the U.S.
9 Million parts
85,000 different parts used in repair and maintenance
29,000 engineering drawings

maximum payload	74,797kg
total material weight	96,615kg
aluminium	63,230kg
titanium	7,850 kg
steel and super alloys	8,165kg
composites	6,940kg

1,524m of hydraulic lines
193km of wiring
272kg of exterior paint
Maximum Take Off Weight: 265,350kg
Speed 460kts = Mach 0.74 = 852 km/hr at
Cruise Ceiling 13,716m
Range 6,455nm = 10,389km

http://www.skybrary.aero/index.php/C17

11 *Through the intelligence, surveillance and reconnaissance research initiative and the Jindalee Operational (Over the Horizon) Radar Network (JORN)*
12 *America's Air Force: A Call to the Future – USAF's 30 Year Strategic Plan, July 2014, p.18*

HERCULES C-130
Entered Service in Australia 1958

Unit cost	$38.5m in 2014
Speed	671km/h (Mach 0.59 at 6,706 metres
Ceiling	10.000 metres with 19,090 kilogram payload
Range	3,335km
Maximum take off weight	69,750 kilograms

www.bga-aeroweb.com/Defense/C-130J-Hercules.html

SUMMARY: The C-17 is almost 50 years younger than the C-130, flies higher, faster, further, and carries almost 4 times more cargo. It also costs over 5 times more to buy one.

Over the next 30 years, the Navy plans to acquire 12 submarines, eight frigates, 14 patrol boats, six landing craft, and two supply ships as well as replace six mine hunters and two hydrographic ships. The Department of Defence will also acquire more than 20 patrol boats to be gifted to regional nations as part of a Pacific Maritime Security Program.

There are two major naval shipbuilding projects underway in Australia today: the Landing Helicopter Dock (LHD) project centred in Melbourne and the Air Warfare Destroyer project centred in Adelaide. The LHD project commenced in 2003, with the contract awarded to BAE Systems (then Tenix Defence) in 2007 at a cost of about $3 billion. The project involves about 850,000 design hours and 5.5 million production hours.

The Air Warfare Destroyer (AWD) project will deliver three Hobart Class warships and an associated integrated logistic support system. An Alliance of ASC AWD Shipbuilder Pty Ltd, Raytheon Australia Pty Ltd and the Defence Materiel Organisation is delivering the project. AWD incorporates an Australian version of the US Navy Aegis Combat System.

The future submarine project is intended to deliver twelve submarines with greater range, longer patrol endurance and increased capability compared to today's Collins Class submarines. The new submarine will be able to conduct anti–submarine warfare; anti–surface warfare; strike; intelligence, surveillance and reconnaissance; electronic warfare; mine warfare; and support special forces' operations.

The Future Submarine Industry Skills Plan reported that according to surveys by the Defence Materiel Organisation, Defence Science and Technology Organisation and RAND Corporation, there are about 3,000–3,500 people involved in defence systems development and

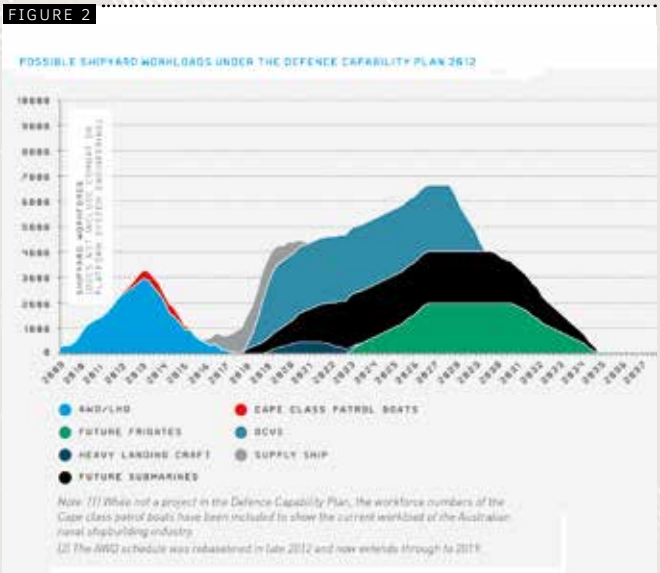
integration in Australia. About 600 are currently working on systems for the LHDs and AWDs. The key skill areas are systems, software, electronic and other engineering disciplines, and integrated logistic support, contract, supply chain and project management.

Since government approval of the LHD and AWD projects in 2007, the Australian naval shipbuilding industry has grown from a workforce of several hundred to several thousand people. But activity has peaked and the workforce is in steep decline into what has become known as the 'valley of death'.

Shipyard workload projections were detailed in the Future Submarine Industry Skills Plan. The most recent forecast based upon the 2012 Defence Capability Plan is shown in Figure 2.

Figure 2: The 'VALLEY OF DEATH' Chart: Outlining the substantial rise and decline of industry activity in order to meet forecast demand.

FIGURE 2



To summarise, Australia needs a Defence Force that has the wherewithal to understand the military technology at its disposal, and utilise it to best effect. In order to do that, both the ADF and other elements of the Australian Defence Organisation must always be, and be seen to be, trustworthy custodians of the military technologies entrusted to us by our allies. This means that the Physical Sciences and Engineering workforce must have the capacity, capability, knowledge and experience to manage the plethora of projects in the pipeline, keep abreast of the technical challenges they present, and ensure that the equipment being dealt with is safe, fit for purpose and offers the best possible value for money.

The magnitude of costs of military materiel is staggering, and unless the Defence Industry is capable of delivering the goods, and the Defence organisation has the resources to ensure the goods delivered are 'as expected', the magnitude of lost economic opportunity is equally so.

According to the Defence Portfolio Budget Statements 2014-15, estimated expenditure on acquisition of specialist military and associated equipment for the ADF, including the estimated budget for all approved and unapproved projects is $6.3 billion, accounting for 50.1 per cent of the DMO's total expenses. Whilst many relate to foreign military acquisitions, Australia must have the capacity and the capability to exercise skills, dexterity and judgement in support of these acquisitions.

Of the 30 top DMO Projects for 2014 - 15, sample key risks relating to Defence Physical Sciences and Engineering workforce capability are as follows:

The key risk for this project is the timely resolution of outstanding technical and supportability issues in order to generate the necessary flying hours to meet the Navy and the Army capability development requirements.[13]

The key challenges for this project are to increase shipbuilder productivity and ensure the most efficient use of current resources.[14]

During 2014-15, this project will experience a delay in planned work finalisation as a result of industry workforce capacity and capability. The key risks for this project are associated with the complex system integration and the availability of appropriately qualified staff.[15]

The key risk for this project, in conjunction with Phase 2A, is the supply and efficient management of shipyard resources required to maintain schedule with three ships in the ASMD upgrade program at any one time.[16]

The key risk for this project remains the mobilisation of resources across government, industry and academia necessary to manage the Future Submarine Program with appropriate international support, informed by our experience and knowledge of similar programs.[17]

13 *Multi Role Helicopter - AIR 9000 Phase 2 Prime Contractor: Australian Aerospace. PBS, p.158*
14 *Air Warfare Destroyer - SEA 4000 Phase 3 Prime Contractor: The AWD Alliance, PBS p.160*
15 *Amphibious Deployment and Sustainment - JP 2048 Phase 4APrime Contractor: BAE Systems Australia Defence, PBS 162*
16 *Anzac Ship Anti-Ship Missile Defence - SEA 1448 Prime Contractor: Anzac Ship Integrated Materiel SupportProgram Alliance (Commonwealth of Australia (Defence) with BAE and Saab, PBS p.162*
17 *Future Submarine – Acquisition - SEA 1000 Phase 1A Prime Contractor: Not in contract, PBS 162*

SECTION 3
THE DEFENCE PHYSICAL SCIENCES AND ENGINEERING WORKFORCE: DELIVERING CRITICAL INTELLECTUAL INFRASTRUCTURE

The purpose of the Defence Physical Sciences and Engineering workforce is to provide science and engineering skills, knowledge and experience to support the requirements of the Australian Defence Force and other government agencies involving the safeguarding of Australia and our national interests.

The technological environment encompasses a wide spectrum, from cutting-edge work in the cyber, hypersonic and nanotechnology domains, to the design and development of camouflage clothing that is functional, durable and comfortable. The technical environment is similarly broad, ranging from the conduct of compliance tests on systems and equipment for safety, reliability and suitability, to ensure they perform as their manufacturers claim they do, to devising leaner ways to conduct maintenance and increase platform availability. From warships to wedgetails, from missiles to munitions, from tigers to trucks, the Defence Physical Sciences and Engineering workforce is engaged in the conceptualisation, specification, design, acquisition, management, maintenance, testing, repair and disposal of the entire Defence inventory.

Our physical geography means that Australia must always retain a measure of defence self-reliance. This means we must also have the capability and capacity to manufacture and sustain essential defence products ourselves, so that we can keep our systems and equipment up and running, and stay 'in the fight' should we ever have to do so from our own shores. As 'parent' builders of equipment like the Bushmaster Protected Mobility Vehicle, the Canberra Class Landing Helicopter Dock, Australian Warfare Destroyer, Collins Class Submarine and the Jindalee Operational Radar Network,[18] we must be in a position to maintain, repair and provide ongoing support to these fleets through life. As 'users' of high-tech systems like the Joint Strike Fighter, E-7 'Wedgetail' Airborne Early Warning and Control and the EA-18G 'Growler' aircraft, we must be more than just the operators at the end of a very long, very expensive supply chain; we must be able to know what we need to do, how to do it, and how to keep doing it, in order to be ready and capable of doing it for ourselves.

The ARH (Armed Reconnaissance Helicopter) Tiger is one of the most advanced armed reconnaissance helicopters in the world today.[19]

Whilst most of the technologies have applications in the non-military context, their employment may be radically different from their military counterparts; their unique application means that specialist understanding is required. An example of this is Navy's long-range radars, which, like their civilian counterparts in airports, track aircraft. However, unlike civilian radars, Navy's radars are required to track aircraft and missiles flying at supersonic speed, changing altitude at random, and doing everything possible to avoid detection. Also, unlike its civilian counterpart, warships change location relative to their target, adding an extra layer of complexity in the calculation to locate and track the target and report to other ships and aircraft in the immediate vicinity.

In order to understand the type of workforce Defence needs to deliver military capability, we need to understand what is meant by the term. The Defence Capability Handbook describes military capability as follows:

"Military capability is crucial to the defence of Australia against direct armed attack and to protect our national interests. Maritime, land, air and information capabilities provide Australia with the capacity to meet our strategic interests through the ability to act independently, lead military coalitions and make tailored military contributions. It is important that Australia maintains a regional strategic military capability advantage in order to deter conflict, allow us to prevail in conflict if deterrence fails, and to minimise our casualties and materiel losses. In the Defence context, capability is the capacity or ability to achieve an operational effect. An operational effect may be defined or described in terms of the nature of the effect and of how, when, where and for how long it is produced."[20]

By its very nature, the delivery of military capability to counter the threats Australia is likely to face is a complex undertaking. It requires a workforce that is not only able to understand the mechanics of the technology and weaponry it is likely to encounter, but also has the wherewithal to devise ways to defeat the threats that a future adversary may use against Australia.

> "It's important to realise that there is nothing available off the shelf at the moment for conventional submarines that is fit for Australia's purpose."[21]

Defence technologies require specialist knowledge and skills, which limits the ready availability of suitably qualified engineers, technologists and technicians to fill unexpected workforce gaps. Put another way, the Defence workforce cannot be supplemented from external sources as quickly or readily as other sectors competing for the same human resources. In addition to skill, knowledge and experience requirements, the Defence workforce demands additional criteria such as security clearances, background checks and Australian citizenship, further shrinking the pool of available candidates.

In some instances, the unique nature of Defence work, especially in relation to the technologies in use, means that Defence has little alternative but to 'grow their own' workforce. Unlike commercial enterprises, Defence must always have the capacity to expand, the flexibility to adapt, and the ability to comprehend new and developing technologies in order to provide the best possible advice and service to the ADF and the people of Australia.

An Engineers Australia commentator recently described CSIRO, DSTO, NICTA, ANSTO and other related vehicles of government as 'intellectual infrastructure', stating: "The intellectual infrastructure being disbanded cannot be readily outsourced when required."[22] He further commented: "…it is difficult to understand the Federal Government's budget strategy which appears to be sacrificing long term skills and capability for short term budget demands. It appears to be an abandonment of intellectual capital."[23]

This concept could be applied to the Defence Physical Sciences and Engineering workforce as a whole, which contributes to the Defence effort through a stable, balanced and harmonised workforce whose skills, knowledge and experience combine to provide collective insight, experience and wisdom to the Defence Program, delivering a capability brick of intellectual infrastructure.

Defence is not as competitive as other industry segments that are vying for virtually the same skills and knowledge resources, such as mining, energy and communications. It is constrained by fixed federal budget allocations and subject to intense scrutiny, and does not have the capacity to rapidly expand and contract compared to commercial enterprise. Another key difference is that, unlike commercial undertakings, Defence and other government agencies are limited in their ability to 'shelve' existing projects until more favourable conditions make the activity more profitable to undertake. Defence is driven by the need to be ready and available to respond at a moment's notice to direction from government to protect Australia and our national interests, and that is an obligation that cannot be delegated to private enterprise.

In addition to managing, maintaining and sustaining the technologies of the current and future Defence inventory, the Defence Physical Sciences and Engineering workforce uses its considerable intellectual capital to re-invest in the way Defence does business. In doing so, Defence realises a true efficiency dividend measured in opportunity benefit, rather than pure cost terms[24], as opposed to the current efficiency dividend metric of a percentage dollar budget cut.

Some examples of true value-adding efficiency dividends achieved by the Defence Physical Sciences and Engineering workforce are described in the following case studies.

CASE STUDY 1: EXPLOSIVE ORDNANCE AND GUIDED WEAPONS ARMAMENTS TECHNICIANS, ORCHARD HILLS, NSW

Explosive Ordnance and Guided Weapons Armaments Technicians are responsible for managing and maintaining guided weapons for the ADF. The Guided Weapons Branch consists of System Program Offices (SPOs), stand-alone major capital equipment project teams and supporting Directorates. The Explosive Ordnance branch undertakes in-house maintenance activities at its facilities in HMAS Stirling (Electorate of Brand), HMAS Waterhen (Electorate of North Sydney), and Defence Establishment Orchard Hills (Electorate of Lindsay).

The contribution that these specialist technicians in this very narrow field make to ensure weapons are ready and available to deliver their payload 'on-time, on-target, first-time, every time' is not widely understood. This particular field requires attention to detail, and margins of error are extremely tight - for good reason. It also requires strict and exacting standards of technical documentation, which means that in addition to skill of hand, the workforce must be excellent communicators. As one technician commented: "As a result of organisational change within the previous Explosive Ordnance Division, technicians now have direct responsibility for the maintenance publications they use, due to the transfer of this function from a dedicated Technical Publications area. Holders are also now required to annually muster, compliance check and incorporate changes to all publications held." This means that as well as understanding their job, EO Technicians must also have a broader understanding of the structure and strictures of technical publications.

The need for a Defence workforce that can work in harmony with their industry counterparts in order to deliver a capability outcome for Australia is not only understood, but, under the current efficiency dividend-based rationale, is virtually unachievable otherwise. As one technician put it: "We have had people travel nationally and internationally to work on faulty weapon systems…Over the last 2 years, we have been required to provide maintenance personnel as Government Furnished Material (GFM) to supplement contractor missile maintenance facility resources. This has involved us learning new skills, setting up the workshop and conducting maintenance to meet contractor requirements, as well as continue to meet Defence compliance requirements."

Due to the dearth of technical personnel in this area, Defence technicians are also regularly called upon to provide advice to contractors in relation to the incorporation of Commonwealth maintenance policies and procedures in relation to supply, explosives, security, and airworthiness practices. "We can only achieve a successful result because, while the contractors have the product specific knowledge, we have the understanding of systems, processes and are in a position to look at how this fits in with the overall Defence missile maintenance and certification picture."

More recently, the need for a sustained Defence EO and Guided Weapons capability, with a capacity for rapid surge, has been demonstrated. The unforeseen escalation of hostilities in Syria and Iraq, and subsequent deployment of Australian FA-18 Super Hornet fighter aircraft to the Middle East, will increase the demand for their skills, knowledge and experience. In relation to the pressure of surging to meet military exercise delivery, one technician commented: "We have had to work shift work just to meet exercise requirements." Unlike the controlled environment of an exercise, where hardware availability and their effects can be simulated, and items either pre-positioned or stockpiled in advance of exercise start, an unrelenting and determined aggressor will only respond to genuine military action against it. This means that, for example, a failure to have guided weapons and ordnance available to deny enemy access to a strategically important area will result in the loss of that area. One can only imagine the pressure to deliver ongoing support over a sustained period and, no doubt, a 'lessons observed' recommendation will be to provide a more robust Defence EO and Guided Weapons surge capability.[25]

Over the last few years, Explosive Ordnance and Guided Weapons system technicians have also been involved in the decommissioning and disposal from service of several weapon systems. Whilst this appears relatively straightforward, the activity includes removal of extremely sensitive and inherently hazardous components. The unique nature of guided weapons has meant that technicians were required to use their expertise to develop and implement procedures for disassembly and physical disposal of the weapons and associated equipment, which previously did not exist in Australia. As one technician observed: "The direct savings to Defence in the reduction of the bulk of items requiring special handling was substantial, as the transport of dangerous goods is extremely expensive. The indirect savings to the Commonwealth is that now we have the processes, procedures, skills, experience and confidence to continue to do so into the future."

Guided Weapons Maintenance Office personnel have been involved in the introduction into service of AIM-9X[26], AMRAAM[27], JASSM[28], JSOW[29] and Hellfire[30] missiles during the last 4 years and this will continue to occur in the near future to support FA-18 'Super Hornet' and EA-18G 'Growler' aircraft. These new weapons have increased sensitivity and require a greater level of compliance with external agencies which has resulted in increased workload in terms of coordination, audit, storage, handling, transport and maintenance. "Sure, each weapon could be managed by their Original Equipment Manufacturer (OEM), but if anyone other than us was to manage the inventory as a whole, I'm not sure the US would approve outsourcing weapons, in particular guided weapons, maintenance from a Government Organisation to a third party, like a central contractor, which I think DMO are considering. This is a critical consideration due to intellectual property and the number of different missile OEM's that are associated with the missiles we currently have in the Defence inventory." [31]

Despite the pressure and recent surge requirement to support a potentially long-running air campaign in the Middle East, the uncertainty of sustaining this workforce is shaping decisions of technicians working for Defence. "In the meantime, we are being affected by recruitment freezes and the uncertainty is resulting in personnel resigning from the Public Service. We have recently had an employee leave that has been with us since 2007, has had significant funds spent on training and is a critical employee required to ensure a capability is available. Despite all the noise about retaining critical capability, the departure of this employee is a sad reality, and a pity, given that we definitely already do a difficult, and sometimes dangerous, job that is technically challenging, technologically interesting, and value-adding."

18 *As stated in the reference Australia is the world leader in high-frequency, skywave over-the-horizon radar (OTHR) technology, highlighting the need for a competent and capable workforce to understand, and in some cases implement, required capabilities. http://www.dsto.defence.gov.au/innovation/jindalee-operational-radar-network.*
19 *Source: http://www.army.gov.au/Our-work/Equipment-and-clothing/Aviation/ARH-Tiger*
20 *Defence Capability Development Handbook 2014, Chapter 1, p.2*
21 *Yaxley, L. http://www.abc.net.au/news/2014-10-16/liberal-senators-urge-government-against-buying-overseas-subs/5817168, 16 Oct 2014*
22 *The Threat to Our intellectual infrastructure – Hitchiner, P., The Journal of Engineers Australia, August 2014 pp.32-33*
23 *Ibid.*
24 *Opportunity cost is the cost of an opportunity foregone in order to do a non-value adding activity. Opportunity benefit is the foregoing of lost opportunity to realize a value-adding activity in its place.*
25 *Traditionally, we cite 'lessons learned'. In this instance, 'lessons observed' suggests that the lesson is not learned until the learning outcome is incorporated into future practice.*
26 *The "Sidewinder" short range Air to Air Missile produced by Raytheon*
27 *The AIM-120 "Slammer" Advanced Medium Range Air to Air Missile produced by Raytheon*
28 *The AGM-158 Joint Air to Surface Standoff Missile is an air to surface Missile produced by Lockheed Martin*
29 *The AGM-154 Joint Stand Off Weapon is an air to surface precision 'Glide Missile' produced by Raytheon*
30 *The AGM-114 "Hellfire" is an air to surface Helicopter Launched Missile produced by Lockheed Martin*
31 *As noted above, there are two separate Original Equipment Manufacturer companies, and the systems that support them are subject to strict Military Intellectual Property protocols.*

CASE STUDY 2: DEFENCE VEHICLE TESTING FACILITY, MONEGEETTA, VIC

What happens behind the gates at Monegeetta (Electorate of McEwen) is usually kept reasonably quiet. At the site near Sunbury, Victoria, vehicles are tested for performance and durability, in terms of their ability to negotiate obstacles and gradients, as well as their ability to work in extreme conditions of mud, sand and water. The facility is able to simulate the various conditions described in military specification (MILSPEC) documents, which land forces are likely to encounter in the field, or whilst on operations.The ground has been in use since World War Two, and has been progressively upgraded to keep pace with the changing performance demands of a more modern, mechanised military.

More recently it has undergone extensive refurbishment, due to the relocation of Land Engineering Agency (LEA) Test Services from Defence Site Maribyrnong (DSM) to the Monegeetta Proving Ground.[32]

Vehicles are driven on cross-country courses, on dirt, gravel and sealed roads, through pools, sand and mud pits, up grassed slopes, over rubble and up concrete stairs. In addition to traversing steep terrain (to check for roll stability), the ability to negotiate a paved grade of up to about 30 degrees allows the performance of vehicles to be determined. Turns, winching, towing capability, tyre aggressiveness and track tread patterns are all tested.

The Mechanical and Environmental Laboratory (MEL) contains purpose-built hot and cold chambers to enable vehicle testing over a range of climatic conditions to be undertaken as well. There are tilt tables to test roll-over and vehicle fluid leak inception angles, and platforms to test centres of gravity, which is extremely important when loading equipment into aircraft or lifting using slings. The Electronic and Communications Laboratory (ECL) provides electro-optics testing, electro-magnetic compatibility and electrical testing and calibration. Virtually everything a heavy vehicle manufacturing or off-road test facility should have is at Monegeetta…and more.

In October 2013, during a visit to the facility, Assistant Defence Minister Stuart Robert said the army was looking to replace its entire vehicle fleet in the greatest transformation since World War II [33], including up to 1300 Hawkei vehicles, thousands of Mercedes G-wagons, and heavy trucks and trailers currently in use. The Hawkei is an Australian designed and built protected mobility vehicle that has undergone extensive testing at Monegeetta and, subject to approval, will be built for the Army by the Thales Protected Mobility Vehicle Division in Bendigo in 2016. The project, if approved, will provide income to both Bendigo (electorate of Bendigo) and the Protected Brisbane Support Centre (BSC) at Pinkenba (electorate of Lilley), North East of the Brisbane CBD.

A Unimog on the Articulation Gauges

A M113 Armoured Personnel Carrier on the incline ramps

32 *The Parliament of the Commonwealth of Australia, Parliamentary Standing Committee on Public Works, Land Engineering Agency Test Services Relocation, Monegeetta, Victoria; March 2008*

33 *Valenta, A., Sunbury and Macedon Ranges Star Weekly, 22October 2013 "Hawkei Shows it has the goods at Monegeetta Proving Ground"*

Accompanying Minister Robert to the proving ground, Major General Paul McLaughlin commented: "We face a range of threats (like in Afghanistan) that simply haven't existed before, not just threats from environmental conditions … insurgent threats, weapons, (and) explosive devices."[34]

Mack truck and float on 'B-Road'

Test driving on 30degree incline

A Hawkei on the Monegeetta tilt table

Like many test-type facilities, the range of knowledge and experience required to do the job at Monegeetta far exceeds the position descriptions the technical support staff work under. Consider how long it takes to get a feel for the family car in terms of turning circles, power response, and blind spots and handling idiosyncrasies; now consider driving the vehicle to its design limit, and the degree of skill and dexterity it takes to achieve that outcome. As one technician describes it: "This is much more than a driving task – we cover difficult terrain, and, whilst some of the tasks are 'man-made', they are no less dangerous than if you were driving them in the field – we drive these vehicles at the very edge of the military safe operating envelope so that our soldiers can be confident that they have one less thing to think about when they're out there doing it for real."

The challenge confronting the technicians of Monegeetta comes into perspective when one considers the tight margins and physical demands of producing reliable and repeatable test data. "It's not just about holding a particular course and speed – we need to maintain specific 'G-force' loadings, and safely manoeuvre prototypes whose performance, handling and response under high stress conditions are unknown. The irony is that we work out how to drive them, then teach the driving instructors, who then qualify us to drive the vehicles."

The aggregated knowledge and experience extends beyond the proving ground and into other areas of the test facility. "We're proud of what we do here, especially with respect to our survivability guys' work - when the Army says things like no soldiers have been lost while inside the vehicles we've certified means we must be getting things pretty much right."

As noted by Major General McLaughlin, the Survivability Section[35] considers the effects of possible threats Defence vehicles are likely to face, and works with designers and operators to reduce these effects. In order to understand them, dynamic displacement and force measurement testing is conducted on vehicles that are subjected to small and large calibre gunfire, and in some cases, controlled explosions in the Enclosed Light Armaments Facility (ELAF).[36]

The task of gathering experimental data means that all technical team members are multi-skilled; each is able to properly align and mount strain gauges, accelerometers and other measurement devices, connect to data loggers and assess initial results. "There are tricks to selecting, bonding and aligning precision measurement devices so that they produce valid results, and this is a skill that can only be learned on the job."

The need to have technology savvy and experienced people available at a moment's notice to deliver Defence outcomes is an inalienable responsibility of the Australian Government. In relation to sharing military technology, an allied government is one of very few entities likely to be entrusted with another's military technical secrets.

34 Ibid.
35 More properly known as the Land Combat Systems (LCS) Branch, within the Land Engineering Agency (LEA), which is within the Land Systems Division (LSD) of DMO.
36 Op cit (parliamentary works) p.8

SECTION 4
THE IMPORTANCE OF THE DECISIONS THIS WORKFORCE MAKES, AND THE THINGS THEY DO

The people of the Defence Physical Sciences and Engineering workforce make decisions every day that directly and indirectly affect the safety of ADF personnel, from calculating the roll stability and centre of gravity of heavy vehicles to assessing the survivability of Defence members from weapons likely to be used against them. The workforce exercises considerable skill, dexterity and judgement, making decisions in relation to manufacture and maintenance outcomes for Defence materiel. As a result of their commitment, dedication and motivation, Defence technicians and technologists assure the safety of the soldiers, sailors, pilots and air crew who live with, and depend on, that equipment.

The Physical Sciences and Engineering community makes decisions every day that are critical to the readiness of military equipment in service, from the development of functional performance specifications, to the provision of statements of work, production and assessment of tenders, and acceptance criteria to ensure purchase of the right equipment for Australia. This workforce also makes decisions in relation to ensuring that locally manufactured equipment is built to the right standards through observation, measurement, assessment, testing and witnessing at the design, build, installation and commissioning phases. The group also applies the same rigour to in-service equipment and systems undergoing upkeep, upgrade or update activities.

Specifically, the Defence Physical Sciences and Engineering community is responsible, in partnership with the ADF, for assuring the technical integrity of ADF materiel.

Defence Instruction (General) LOG 4-5-012 states: "ADF materiel must be designed, manufactured and maintained, to approved standards, by competent and authorised individuals who are acting as members of an authorised organisation, and whose work is certified as correct."[37] In relation to most Defence items, the Physical Sciences and Engineering community are the mainstay of the approval and certification process, doing the required work with necessary rigour in order to deliver an accurate assessment to enable a valid decision to be made with respect to the materiel, reflecting its condition as true and correct.

The quality of the decisions made by members of the Defence Physical Sciences and Engineering community has a direct impact on the Defence Department's performance at the portfolio level. Put simply, poor decisions lead to comparatively low readiness and higher costs, while good decisions result in comparatively higher levels of readiness and lower costs.[38]

To do all this requires the know-how that comes from a workforce of dedicated people with a range of skills, knowledge and experience. A workforce of technically savvy people with the commercial acumen to not only understand, but make smart decisions based on realistic expectations, are worth investing in because their work impacts positively on Defence's 'bottom line', saving money every day.

On the surface, the ability to make sound decisions, and the work that the technical community does to arrive at these decisions appear fairly simple and straightforward. However, the need to consider second and third order consequences over the design life of a system, which can be up to 30 years, requires prudent analysis in order to ensure the finished product performs as expected, where, and when it is needed. Providing a product which takes into account all possible modes of failure and malfunction requires experienced engineers and technicians whose decisions are based on judgements, within the bounds of known science, based on a deep understanding of the behaviour of complex systems and, ultimately, careful assessment of safety and risk.

The importance of having a vibrant, robust and sustainable workforce has been emphasised in several recent reviews of Defence business. The 2011 Black Review[39], which considered the efficacy of the Defence accountability system stated: "Current arrangements are under stress and their failure damages Defence. This stress is manifested in poor outcomes for Defence. Recent examples include: delivery failures for capability projects; non-compliance with AusTender reporting; poor or inappropriate procurement decision-making; poor outcomes in pay for Special Forces and a lack of cost consciousness in the management of day-to-day activity."[40] As stated earlier, poor decisions lead to poor outcomes, whether borne out of ignorance or not.

Black also stated: "…the context of a capped budget and reducing contingency provision increases the level of risk that accrues from ineffective management and consequently raises the bar substantially for effective Defence strategic management and decision-making. Defence will need to be more agile, more efficient, and more effective. In practice this means that leaders need to make and implement better decisions faster and with more assurance."[41] This means that the demand on Physical Sciences and Engineering workers, who form the vast majority of 'hands-on' project involvement, through specification, analysis, assessment, supervision and 'ground truth' reporting will have to be faster, better and stronger in order to support the leaner decision and accountability frameworks. This in turn suggests that knowledge, skills and experience are now even more valuable than in previous workforce cohorts.

A similar dilemma confronts the Defence industry; unless Australia is able to maintain a sustainable technical workforce, it will have little choice but to buy equipment and support from overseas.

37 *DI (G) LOG 4–5–012 Regulation of technical integrity of Australian Defence Force materiel LIST B—ISSUE NO LOG B/8/2010*
38 *In terms of all resources, namely people, budget, schedule and capability availability*
39 *Black, R. Review of the Defence Accountability Framework, January, 2011,Department of Defence, Australia*
40 *Ibid, p.9*
41 *Ibid, p.9*

Far from being the 'clever country', unchecked, Australia will become imprudent, incompetent and impotent – less able to make valid and careful decisions based on effective judgement, unable to repair, maintain or build its own systems and equipment, and eventually, compelled to buy 'off the shelf' solutions.

Unlike other consumer goods, the military hardware market is highly differentiated, and the open market tends to be full of cheap, nasty, and not particularly effective wares. The only way to ensure effective defence is through a balanced combination of alignment with technologically advanced allies, and self-reliance. Australia needs the flexibility to work either independently, or as a combined force with its closest allies. As raised in the Future Submarine Industry Skills Plan[42], as a sovereign nation, Australia should not seek to have its most powerful military weapons built by another country. Equally, as a sovereign nation, Australia should not assume that our allies will be available to provide every assistance we may be in need of, where and when we may need it.

In 2012, Deloitte's considered the Defence Australian Public Service (APS) engineering and technical job family, to "…develop strategic solutions to support the attraction, development and retention of engineering and technical skills across Defence".[43] Key findings suggest that the importance of the decisions that Defence technicians, technologists and engineers make as part of their everyday employment goes largely unnoticed. This is consistent with a documentation review of the Rizzo Review[44] which in relation to Navy's technical workforce found; "poor whole of life asset management, inadequate risk management, poor compliance and assurance, a 'hollowed-out' engineering function, resource shortages in the Systems Program Office in DMO, and a culture that places the short-term operational mission above the need for technical integrity is compromising the availability and sustainment of Navy assets".[45] In response, the Naval Engineering Future State Blueprint (FSB) suggests that the future state Naval Engineering workforce will require the establishment of an "integrated, professional and competent workforce across Defence and Industry for the delivery of Naval Engineering".[46]

The decay of technical mastery in the naval engineering workforce to the point of virtual collapse demanded drastic recovery action to be taken. In relation to the Physical Sciences and Engineering workforce, the Future State Blueprint stated the requirement to "optimise the career management and utilization of the Defence civilian workforce, drawing from professionals, para-professional and associates (particularly in System Program Offices (SPOs) and Specialist Bureaus) so that deep 'in-house' technical mastery is both developed, retained, and utilised in support of platforms".[47]

The circumstances that preceded the Rizzo review underscored the importance of the Defence Physical Sciences and Engineering workforce within Navy and the wider Defence community, and the decisions that they make. Regrettably, through Rizzo, Navy's realisation came at the cost of not having a suitably competent, capable and available workforce to make the smart decisions when they needed to be made.

To Navy's credit, the release of the Naval Engineering Strategic Plan (2013-2017) in 2013 clearly demonstrated the highest level commitment to prevent a recurrence of Rizzo. Specifically, then Chief of Navy, VADM Griggs stated: "Technology is at the very heart of our modern Navy. As we look to the future, our reliance on engineering and technology is not expected to diminish. All of our people need to understand technology's central role, however it is state-of-the-art materiel and engineering excellence that will continue to be the keystones to providing us with confidence to 'Fight and Win at Sea'." [48]

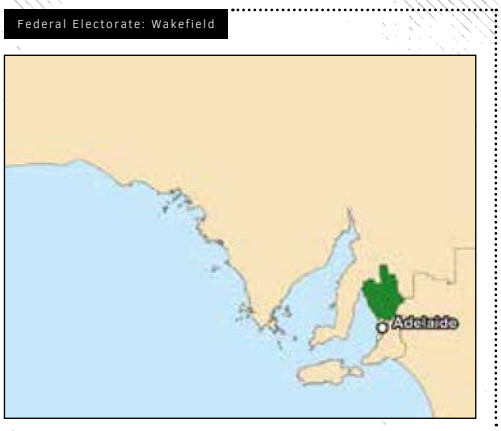
Acknowledgement of the fact that delivery of technological services and technical functions require 'across the board' attention, suggests that this was previously lacking. One could argue that in the absence of spectacular failure in other services, similar complacency may exist in other pockets of the Defence organisation. VADM Griggs reinforced this contention by stating: "All Navy people must understand the fundamental importance of engineering and maintenance to the safety of our people, protection of the environment and the delivery of operational effectiveness. We all have an obligation to provide and foster the climate for proper discharge of these functions and ensure that an appropriate balance of priorities is applied as we consider materiel state among the many tasks that we have to manage…I look to all personnel to play their part in ensuring compliance with proper engineering and maintenance practice as we work together as stewards of our equipment, our people, our reputation and our Navy." [49]

To summarise, the Defence Physical Sciences and Engineering workforce deliver skills, experience, knowledge and capability to make important decisions in relation to ADF equipment, systems and support activities, to ensure Defence materiel is safe, fit for service, and environmentally compliant. The Physical Sciences and Engineering community also provide a stable workforce that counterbalances the generally transient nature of ADF personnel, limiting the effects of corporate memory loss. Its members understand, and apply, the stringent technical regulatory requirements applied to Defence materiel, and ensure the Australian government has sufficient competence, capability and capacity to be a trustworthy user of the military technology secrets entrusted to us.

Above all else, a failure to deliver adequate Physical Sciences and Engineering workforce capability results in decay and degradation of an engineering function that can lead to mission failure, or, worse still, compromise of the ability to assure technical integrity. In the case of the post-Rizzo Navy, the cost of regaining lost reputation and confidence in the ability to assure materiel integrity is likely to far outweigh that of maintaining it at an acceptable level in the first place.

42 Future Submarine Industry Skills Plan, Department of Defence, May 2013
43 Deloitte Australia: Defence Technical Regulatory Frameworks Workforce Review, Stage 3, November 2012
44 Rizzo,P. 2011 Plan to Reform Support Ship Repair and Management Practices, Department of Defence, Canberra
45 Op cit (Deloitte) p.10
46 Naval Engineering Future State Blueprint, Commonwealth of Australia, August 2013,p.32
47 Ibid, p.33
48 Naval Engineering Strategic Pan (2013-2017), Commonwealth of Australia, August 2013, p.5
49 Ibid, p.5

CASE STUDY 3: AIRBORNE PODS • DSTO SCIENTIFIC ENGINEERING SERVICES (SES), EDINBURGH, SA[50]



The Airborne Pods program is a long-running (>20 years) and ongoing DSTO Electro-Optics (EO) research program centred on flight tests using two airborne pods designed and developed by DSTO Scientific Engineering Services, Edinburgh.

The maintenance, upgrades and configuration control of these systems is managed by SES, with a current request to reconfigure one of the systems for a test program requested and funded within an international defence partnership context.

The development of the airborne pods by SES has provided DSTO with a set of high-value platforms to conduct operational analysis of weapons guidance systems, which are unique in their application, as attested by several requests from overseas partners to access them for similar test programs.

In the process of developing these platforms, SES was tasked with handling sensitive information, hardware and IP transferred to Australia under strict government to government agreements.

The SES project team provided the lead role in determining the system requirements and all engineering concepts and solutions, starting with only the concept of operations. Using external or embedded contractors to define the system requirements would have inevitably led to ongoing costs escalation, due to evolving requirements over the years.

Attempts to engage commercial engineering support were ended by the prohibitive costs quoted by contractors. DSTO would not have access to this level of up-front funding for a single task. The development of the systems was initiated in-house by SES with very little task funding and upgraded over many years.

These platforms, together with the proposed research programs, have attracted significant ongoing funding for DSTO, including proposed international collaborations.

The broad range of engineering skills involved in such a development were significant factors in the prohibitive costs estimated by contractors, as several of the necessary engineering skills that were lacking were to be sub-contracted at high costs and with significant risks. SES was able to readily provide most of those skills directly or source them internally in DSTO, and efficiently contract-manage a small remainder.

The DSTO Airborne PODs. This particular unit simulates the behaviour of an Advanced Short Range Air to Air Missile (ASRAAM)

50 *Case studies 3 and 4 are taken from an unclassified report - Defence Science and Technology Organisation, STRATEGIC INITIATIVE O4: SCIENTIFIC ENGINEERING SERVICES REVIEW, 5 June 2014 - provided to the AMWU by DSTO in August 2014, with minimal editing.*

CASE STUDY 4: LAND MOTION PLATFORM (LAMP), DSTO SCIENTIFIC ENGINEERING SERVICES (SES), EDINBURGH, SA

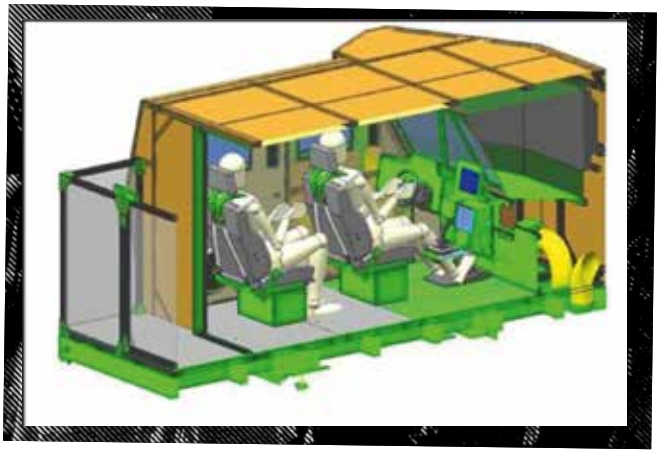
The Land Motion Platform (LAMP) was designed, built and delivered by SES to Land Division (LD) in 2013. An initial approach to the market by LD in 2010 identified only one provider, with the proposal to integrate hardware provided by DSTO (including the simulator cabin) being in the order of $1.35m. This was unaffordable to the research program, so SES was tasked to deliver the facility. The engineering effort provided by SES or subcontracted by SES to deliver system integration to the end of stage 3 of the program was $170k on a full cost recovery basis.

The provider quotation for the same package of work was $570k

The LAMP supports DSTO research in performance of operators, crew and teams in 21st century land mobile operating environments, as envisaged in LAND 121, LAND 400 and LAND 75. With a multi-billion dollar investment planned, understanding and mitigating the effect of motion on cognitive and psychometric performance whilst operating military vehicles and associated computing and communications equipment is one area of study being pursued to assist with successful specification and operation of equipment in that environment.

SES successfully completed this system design and development by employing a dedicated systems engineering approach, coupled with multidisciplinary specialist technical knowledge and strong leadership.

Prohibitive upfront costs and likely further costs escalations during the development of the system would have prevented this development being initiated, approved and successfully delivered without the significant effort and leadership provided by SES, and if commercial support was the only option available to DSTO.



The close relationship that SES staff has with the divisional scientists as 'one DSTO team', is readily understood and accepted within DSTO and the broader defence community. This was evident in the course of defining a coherent set of functional requirements and developing a system concept for the LAMP system. The SES project team provided the lead role in resolving the many competing points of view on the system requirements, by providing timely critical engineering advice, hosting, directing and resolving conflicting requirements to a successful conclusion of a system architecture agreed by all stakeholders.

The IP (intellectual property) developed by SES for the LAMP Simulator project (i.e. specialist simulation software for use within the simulator) is wholly owned by DSTO, with obvious technical and cost benefits for the ongoing operation and maintenance of the system.

The development of LAMP required outsourcing of some specialist skills and these needed to be brought together in a dedicated systems engineering approach. SES provided the critical technical, engineering and financial/contractual control of the project with the efficiency and value for money provided by the 'one DSTO team' relationship.

SECTION 5
THE CHALLENGE OF SUSTAINING THE DEFENCE PHYSICAL SCIENCES AND ENGINEERING WORKFORCE

"To support the capability needs of Defence, enhancing workforce flexibility, retaining essential skills, and achieving cultural reform will remain a high priority for the coming year, and will require sustained effort over several years to effect lasting change."

(Defence Portfolio Budget Statement 2014-15)[51]

This section identifies the current state of Australian industry and highlights shortages in technical trades, effects of competition from mining and energy on other industries, and the diminishing number of skilled and experienced workers as a result of our ageing workforce. It discusses the tendency for commercial interests to 'buy-in' expertise in the short term (and shed it just as quickly), resulting in the 'dumbing down' of core workforces and reducing opportunities to grow the next generation of experienced technicians and tradespeople.

Skills, knowledge and experience are valuable commodities to Defence, both on their own and in terms of the synergies they create. The need to distinguish between the three elements is important, and linking each of them to performance and productivity is important to ensure government delivers outcomes efficiently, effectively and continuously. Delivering the most efficient and effective outcomes enables the Defence portfolio to assure the people of Australia that they are getting the best possible 'bang for their taxpayer buck'.

The Defence of Australia and its national interests requires the Department of Defence to embrace the entire spectrum of technology, requiring it to operate in areas where returns on investment are not necessarily high, rendering them somewhat unattractive to commercial interests. The need to be capable of supporting the ADF where and when needed, is paramount – this means that the Physical Sciences and Engineering workforce must bridge the gap at both the leading, and bleeding edges of technology. There is enormous potential for the value of the mundane and 'unsexy' work to be underestimated when viewing outcomes against expenditure through a purely financial lens, which from the cushy confines of a Canberra conclave, is a very tempting proposition, particularly when efficiency dividends are being sought. In July 2014, the US Air Force released its 'A Call to the Future' strategic vision document[52], citing similar challenges in terms of staying ahead of the technology curve. Specifically, "Increasing importance and vulnerability of the global commons will (also) shape the environment of the next 30 years….Space will continue as a vital domain for the global economy… Cyberspace will only grow as the recognised domain through which critical information must flow at ever-increasing volume and speed."[53]

This means that unless Australian Defence maintains a vibrant and sustainable techno-centric workforce, it will be vulnerable to attack in domains which would not normally be considered as militarily essential domains. The Chairman of the US Joint Chiefs of Staff, General Martin Dempsey, put it simply; "While cyber may be our nation's greatest vulnerability, it also presents our military with a tremendous asymmetric advantage."[54] As a 'middle power' in terms of the global landscape,[55] in order to ensure Australia and its national interests are protected, and for us to continue to be a trusted custodian of advanced technologies from our allies, we need to demonstrate that we 'have some skin' in the high technology game – this means that we must have competent and capable intellectual infrastructure. Australia, through DSTO and other Defence segments, thankfully continues to deliver this outcome.

The consequences of failing to train, sustain and retain an appropriately balanced and available Physical Sciences and Engineering workforce can be intolerable, in terms of lost time due to defects, budget over-runs, mission unavailability and, occasionally, harm to ADF personnel. Whilst the most spectacular and public results of inadequate technology discipline-based decision-making, or a general degradation of engineering capability has been associated with Navy in recent times, there are countless others that go undetected.

Regrettably, poor decisions that are attributable to a lack of skills, knowledge and experience are little more than expensive and avoidable 'own goals'.

A recent study identified the inadequacy of current capability development models in operation across the US as inadequate, rife with industrial-era development cycles that render the products virtually obsolete before they enter full-scale production; the similarity of this situation with some of the more spectacular failures in Defence in recent history is somewhat startling. The wholesale consumption of skills, dexterity and judgment resources in the operation of 'large, complex programs rife with crippling interdependencies' [56] present the ideal conditions for project failure for all but the very best project managers.

A 2012 Deloitte study noted several key findings in relation to the challenge of sustaining a robust and viable Defence Physical Sciences and Engineering workforce, such as the following:

A key risk is the loss of Defence knowledge and experience within an ageing workforce, with an average age of 48. Focus groups frequently identified increased contracting out of engineering and technical work as a key reason for the loss of skills within the APS engineering and technical workforce.

In addition to these factors, the study identified that "the APS engineering employer brand and applicant experience is not tailored to attract the required volume or quality of engineers and technicians".[57]

The June 2014 AWPA Engineering Workforce Study considered the challenge of assessing the scale and scope of the problem at a macro level. It concluded: "Employment levels for engineering professions and engineering-related trades have grown notably over the past few years. The data shows that the labour market has now eased, with significant skills shortages limited to a few occupations."[58] Drilling deeper, pockets of critical shortage were identified, most notably in areas where Defence's skills demand, now and into the future, is likely to be.

Specifically, AWPA noted that: "Some of the large projects in Australia reportedly found it difficult to source skills in both trades and 'high-end scientific, design and other technical consultancy services'. The Recruitment and Consulting Services Association Australia stated that the roles that are difficult to source include those of Mid-Level Planner, Project Controller, Field Engineer, Distribution Engineer, Draftspersons and specialist automotive design skills. Consult Australia noted that the roles of construction project manager and engineering manager are also difficult to source."[59] In relation to upcoming years, "The in-demand skills of the future in engineering will thus require both a depth of specialist knowledge and skills as well as the ability to work in a cross-disciplinary way across diverse knowledge areas."[60] The top 25 projected areas of skills shortage can be seen in Table 1.

In some sectors, attempts to 'paper over the cracks' of technical workforce shortages are achieved by throwing money at the problem. According to Manufacturing Skills Australia: "Despite the easing of demand for engineering skills from the resource sector there still remain areas of shortage, most particularly in the area of engineering technicians with trade skills and dual-qualified engineering trades people. They also report that since these specialist skills are difficult to source, enterprises are meeting their engineering technician needs through the employment of graduate engineers in those roles."[61] This again demonstrates that the organic Defence Physical Sciences and Engineering workforce is a resource to be cherished.

Recently, a leaked internal audit of the Defence Materiel Organisation made the following conclusion:

- The state of the DMO Engineering and Technical workforce is a risk to Defence capability. DMO has limited visibility of their workforce skills. DMO has no targeted strategies for attraction and retention of the right skills and resources required for future capability. DMO has no ability to model engineering and technical workforce requirements for the future. It appears that the DPG Shared services arrangement does not support DMO's strategic workforce management program as they do not have clarity from DMO on what workforce gaps they have in relation to skills, experience, qualifications and diversity.[62]

The source audit also found the following:

- An 18 percent vacancy rate in the engineering and technical workforce, which could result in critical vacancies in light of recruiting constraints and proposed down-sizing;
- That DMO does not have a recruitment strategy to target their future skills or demographic gaps;
- An average age of 52 for the engineering and technical workforce, meaning a further shortfall in three to five years when the older, more experienced members of the workforce retire: and
- A workforce system that is neither capable nor robust enough to deliver high employee satisfaction and staff retention.

The audit effectively states that the DMO has little concept of the structure of their workforce, what they need to do their job effectively, and what the true capability gap actually is. In other words:

The DMO as an enterprise does not have visibility of the skills gaps in their engineering and technical positions. Underqualified personnel occupying technical positions may pose a risk to Defence.[63]

Unconscious incompetence is the state where an individual is unaware that they don't have, or even need a particular level of skill, knowledge or experience. Conscious incompetence is the state where someone knows they want to learn how to do something but are unable to do it. Conscious competence occurs when a particular task can be achieved but requires unswerving concentration, and unconscious competence is when the task is mastered and no deliberate thought is given to it - like riding a bike. [64]

As stated earlier, a fundamental principle of technical regulation is that the work is carried out to approved standards, by competent and authorised personnel, acting in authorised engineering organisations, whose work is certified as correct. Lost competency through insufficient knowledge, experience and skill results in poor decisions being made by people who don't understand the level of risk they are recommending the organisation accept - the unconscious incompetents. Regrettably, in an organisation unwilling to recognise the deadly consequences of unconscious incompetence in relation to the technical regulation of materiel, it is only a matter of time before catastrophe strikes, and a matter of luck as to how many suffer as a result.

To summarise, in terms of Physical Sciences and Engineering workforce characteristics, the most highly sought-after skills in coming years are virtually a perfect match for the workforce currently in Defence. Accordingly, the ability to attract, sustain and retain skills, knowledge and experience within the Defence workforce will be an increasingly difficult task. Any interruption to the ability to provide credible intellectual infrastructure, and a capable and credible technical workforce to support it, has the potential to cause Australia to lose its status as a trustworthy custodian of the advanced military technologies of our allies, and this is a consequence of workforce incapacity we all can ill afford.

Worse still, increasing workforce fragility through hollowing-out of PSE functions and replacement with less qualified and knowledgeable people leads us to expect that our soldiers, sailors, pilots and air crew will suffer the consequences of unconscious incompetence.

Table 1: Employment projections for engineering-related occupations by ANZSCO code, February 2014 to February 2019, four-quarter average. Source: AWPA projections based on ABS, 2013, Labour force survey, custom request.[65]

ANZSCO Code	Description	Employment level in 2013, average (000s)	Projected level in 2019 (000s)	Employment growth 2013 -19 (000s)	Average annual growth 2013-19 (%)	RANK
1331	Construction Managers	75.5	89.9	14.4	3.0	5
1332	Engineering Managers	19.6	26.6	7.1	5.3	1
2331	Chemical and Materials Engineers	5.3	5.2	-0.1	-0.2	14
2332	Civil Engineering Professionals	44.6	50.8	6.2	2.2	7
2333	Electrical Engineers	22.5	25.3	2.8	1.9	9
2334	Electronics Engineers	8.3	8.5	0.2	0.3	13
2335	Industrial, Mechanical and Production Engineers	34.1	29.9	-4.2	-2.2	17
2336	Mining Engineers	12.1	13.9	1.9	2.4	6
2339	Other Engineering Professionals	8.3	10.1	1.8	3.3	4
2613	Software and Applications Programmers	88.6	100.5	11.9	2.1	8
2631	Computer Network and Systems Engineer	25.5	31.9	6.4	3.8	2
2633	Telecommunications Engineering Professionals	7.7	9.5	1.8	3.5	3
3122	Civil Engineering Draftspersons and Technicians	13.1	12.4	-0.7	-0.9	16
3123	Electrical Engineering Draftspersons and Technicians	7.9	8.7	0.7	1.5	11
3124	Electronic Engineering Draftspersons and Technicians	5.8	2.1	-3.7	-15.4	21
3132	Telecommunications Technical Specialists	3.4	2.4	-1.0	-5.5	19
3221	Metal Casting, Forging and Finishing Trades Workers	2.5	1.5	-1.0	-8.3	20
3222	Sheet Metal Trades Workers	8.7	7.1	-1.6	-3.3	18
3223	Structural Steel and Welding Trades Workers	78.4	81.4	2.9	0.6	11
3231	Aircraft Maintenance Engineers	11.2	12.4	1.2	1.8	10
3232	Metal Fitters and Machinists	115.4	118.6	3.1	0.4	12
3233	Precision Metal Trades Workers	7.0	6.8	-0.2	-0.6	15
All engineering SPOL occupations		**605.6**	**655.5**	**49.9**	**1.3**	

51 *Department of Defence, Portfolio Budget Statement 2014-15, P.23*
52 *America's Air Force: A Call to the Future, US Air Force, July 2014*
53 *Ibid p.7*
54 *Ibid p.17*
55 *A generally accepted view is that a middle power is one that is unable to exercise substantial influence on its own in order to achieve its national interests (i.e. not a Superpower), but, through military, economic and other behaviours has the ability to participate, and thus shape, global events. For countries that are not acknowledged as Superpowers, membership of the G20 organisation is generally a strong indicator of status as a medium power.*
56 *Op cit (USAF 2014-15) p.10*
57 *Op cit (Deloitte) p.5*
58 *Australian Government, Australian Workforce and Productivity Agency, Engineering Workforce study, June 2014, p.48*
59 *Ibid, p.70*
60 *Ibid, p.70*
61 *Ibid, p.73*
62 *EY Internal Audit of the Professionalisation of Engineers (2013/14 No.6) DMO 23June 2014*
63 *Ibid, p.4*
64 *Howell, W.S. (1982). The empathic communicator. University of Minnesota: Wadsworth Publishing Company, p.29-33*
65 *Adapted from AWPA Engineering Workforce Study p.36*

SECTION 6
THE CHALLENGE OF GROWING WORKFORCE CAPABILITY

"Nothing that is worth knowing can be taught" (Oscar Wilde)

Thus far we have considered the challenges associated with sustaining Defence Physical Sciences and Engineering workforce elements that are either hollow, unstable, or possibly under threat of extinction from knowledge and experience atrophy due to a failure to recognize, acknowledge or plan for transfer and succession to the next technological epoch. Regardless of the jump in technology, remnants of fundamental skills, dexterity and judgement, borne out of experience, will always remain. The nature of warfare and military service means that there will always be a requirement for people to exist somewhere in the value chain, and this means that there will always be a requirement to grow a workforce capable of delivering the technical and engineering support functions to meet that requirement.

Workforce planning is a key element in the process to quantify, analyse and understand workforce demand so that appropriate strategies can be put in place to meet it. The Australian Public Service Commission, in its APS Workforce Planning Guide, notes that "an organisation's workforce is one of its largest assets and investments and, as such, there is an obligation and a business imperative to plan it properly. Every organisation requires skills and capabilities, and therefore people to deliver its business outcomes. Particularly in knowledge-intensive organisations, such as government agencies and departments, people are vital to the effective functioning of (that) organisation".[66]

Unless we can reliably predict the what, where and when of ADF activity into the future, adoption of a 'just in time' approach to military readiness is an extremely risky undertaking.

Workforce planning theory identifies 3 key elements in the workforce plan; forecasting future demand, converting that demand into people, and comparing actual requirements in conjunction with technological and managerial improvements to deliver a right-sized workforce. [67]

The ebb and flow of technical workforce importance in relation to business outcomes has been a challenge to industries other than Defence. One author observed that organisations such as Honeywell Inc. and GE meet the needs of their technical workforce to grow through the development of viable technical career ladders with increasing position responsibilities, blending career benchmarks with increasing management positions. These are successful companies that grow, sustain and retain staff, thereby reducing sunk costs associated with continuously inducting new staff. In other companies, where positions lacked appropriate authority and responsibilities, unbalanced combinations of technical and non-technical workers occurred, career 'blind alleys' were created, and dysfunctional workforces existed.[68] One could argue that unless Defence takes steps to assure a balanced and capable technical workforce as a priority, it runs a serious risk of becoming misshapen, moribund, marooned, and malcontent.

As discussed in section 5, Navy confidence in their ability to assure technical integrity suffered a huge dent in the fallout from the Rizzo Review, and wholesale changes are underway. In the Naval Engineering Strategic Plan 2013-17, Head of Navy Engineering, Rear Admiral Uzzell, outlined a roadmap to recovery, described below:

> "Over the next 5 years, if we are to achieve what is required of us by the Rizzo Review, it is necessary for the following to be achieved -
> (a) A continuous increase in the mastery in, and knowledge of, the technology employed in the maritime domain,
> (b) A workforce that is organised, educated, trained, and consequently capable of sustained delivery of the engineering functions that are required to generate the materiel outcomes required during each phase of the maritime capability life-cycle,
> (c) A clearly defined engineering management regime that allows for responsibility and accountability for the outcomes of engineering functions to be allocated as it best suits the Force Element, and
> (d) A relevant, contemporary, and suitable Seaworthiness Assurance Framework that assures the delivery of safety, environmental protection, and operational effectiveness outcomes."[69]

The cost in terms of rebuilding the Naval Engineering capability will probably never be fully captured, as it must take into account costs associated with providing stop-gap measures to enable ADF assets to proceed to sea, the opportunity cost of dedicating resources to the recovery activity, as well as the cost of the many avoidable defects resulting from the decline in knowledge and experience as Navy's engineering capability collapsed inwards.

But Navy is not alone.

A common adage is that:"We must learn from history or be doomed to repeat it."[70] According to some analysts, virtually the same thing happened to the Air Force almost two decades ago. A steady degradation of technical and engineering support capability in the late 80s, organisational fragmentation and cuts disguised as efficiency dividends accompanying initiatives such as the Commercial Support Program (CSP), Defence Efficiency Review (DER) and Defence Reform Program (DRP) resulted in a decimation of Air Force technical capability. According to one commentator: "Regrettably, government-driven changes led to the disbandment of the Engineer Branch in the RAAF which, with the sweeping organisational changes that followed, resulted in a wide range of highly successful policies, systems, and procedures, built up over some 70 years of experience, being largely lost. In short, the Chief of Air Force had lost visibility and control not only of his technical resources, but also the airworthiness state of his fleet and that of the other Services."[71] A key difference between the Air Force and Navy experience is that for Air Force, a less than full complement of technicians and the Defence technical support in a squadron means less aircraft available, whereas for Navy, a reduced complement of technicians and or system defects could mean that the ship may be unable to sail.

If we assume that the Air Force model is typical, and accept that airworthiness is currently at an acceptable level, the time between decay and recovery is in the vicinity of 15 years.

The key challenge for any employer is how best to retain, transfer and sustain the collective knowledge and wisdom acquired through individual experience. In large organisations like Defence, this can be especially difficult, as decisions are normally made at the aggregated 'Branch' level, such that pockets of criticality are unlikely to appear. However, this does not mean that the effort to identify and retain key staff should not be made. According to Hartel: "In organisations where specialist skills that have been enhanced by unique experience exist, it is worth making the effort to retain an employee, because it will generally cost less (both in dollar terms and organisational impact) than the costly and time-consuming process of recruiting and training a new employee to a similar expertise level."[72]

The challenges confronting Defence in terms of growing, sustaining and retaining a balanced and viable Physical Sciences and Engineering workforce is approaching a 'perfect storm' scenario – an ageing workforce, rebounding global economies, a resurgent resource sector and improving outlook for several key Defence commercial projects means that competition for talent will be fierce. On the basis of National Centre for Vocational and Educational Research (NCVER) data, the 2012 Defence Industry Workforce Strategy stated "NCVER data suggest there will be substantial growth in supply of skills in most trades in the period to 2020, although NCVER's projected decline in supply of tradespersons in the electrical and electronic trades is concerning given the key role of this group in the Defence materiel supply industries. Overall, the key challenge is not the level of supply in most trades until 2020, rather it is the likely extent of competition for these skills from other industries, especially the resources sector."[73]

Whilst some easing of retirement pressure has been achieved through the abolition of the compulsory retirement age for APS members, efforts to retain Physical Sciences and Engineering people whose skills, dexterity and judgement is valued, appear haphazard at best. According to AWPA, "little is being done currently in the engineering workforce to retain the experience and skills of mature-age engineering workers".[74]

> "Defence would be laughing if it did more to hang on to the talent, young and old, with a proper structure that worked – at the moment they come in, the old guys train them, and then the young ones head back to town to be a foreman or site manager, because the opportunities to get a pay rise or a promotion here just don't exist."[76]

There appears to be little recognition of the 'pig in the python' workforce bubble created by the baby boomer generation, which is affecting many developed economies.

According to a 2007 Deloitte article: "As the baby boomer generation reaches retirement, there will be significant implications for most sectors in economies of the developed world. Few sectors are more highly impacted by the ageing population than government. Government itself faces a rapidly ageing workforce: the civil service is ageing more quickly than other sectors. In the United States, for example, 60 percent of the federal civil service is older than 45 years – nearly double the 31 percent in the private sector, with only 3 percent of the federal workforce less than 25 years old. In Canada, some provincial governments could lose up to 50 percent or more of their workforce within seven years. To replace the lost talent, the provinces will need to compete with employers that have been adapting more quickly to the changing demands of new workers. In Denmark, almost one-third of the public sector workforce is above the age of 50. The average employee is more than 10 years older than in the private sector."[75] A similar phenomenon is repeated in Australia. However, this is not the only factor: the substantial attitudinal differences between the outgoing baby boomers and their Generation Y 'replacements' means that the cycle of replacement demand for skills will be shorter, further increasing the value of older, more stable (i.e. less

inclined to job-hop) employees. Accordingly, Defence must devise strategies that can enable it to win the war for talent and sustain a balanced workforce in competition with industry.

Presently, the only mechanism that attracts good young people and retains older, experienced people, and encourages those on the cusp of exiting the workforce is an appropriately structured career path with concomitant remuneration. As one Physical Sciences and Engineering worker put it: "Defence would be laughing if it did more to hang on to the talent, young and old, with a proper structure that worked – at the moment they come in, the old guys train them, and then the young ones head back to town to be a foreman or site manager, because the opportunities to get a pay rise or a promotion here just don't exist."[76]

According to Skills Australia: "Many of the jobs in the Defence materiel supply industries are highly skilled, in terms of requiring advanced qualifications and extensive workplace experience. These types of specialist skills are frequently subject to significant competition between employers. Moreover, given the nature of the Defence materiel supply industries, the labour pool is limited to those able to gain appropriate security clearances for their roles."[77]

To summarise, the challenge of growing Physical Sciences and Engineering workforce capability is substantial. The outgoing generation of baby boomer workers, who value the opportunity to acquire skills, knowledge and experience in a single organisation, working steadily towards a position from where they can mentor and impart their wisdom to those that follow in their footsteps are being replaced by a generation of workers that prefer to produce a career 'portfolio', based on the best immediate deal for them. The compound effect for Defence is the potential to lose corporate memory from highly experienced retirees and have no real opportunity to grow it, as it currently has neither the structure nor the remuneration packages that are sufficiently competitive with commercial, mining and energy sectors to attract new employees, retain established workers, and encourage the most knowledgeable, experienced and dexterous to delay their retirement plans.

66 *APS Commission, Workforce planning guide "Workforce planning explained", December 2011, p.13*
67 *Human Resource Planning: A Pragmatic Approach to Manpower Staffing & Development, Burack, E., Mathys, N., Brace Press, 1996, P.398*
68 *Ibid, p.406*
69 *Naval Engineering Strategic Plan(2013-2017), August 2013, p.9*
70 *Attributed to Churchill, Hegel and others over time. A more contemporary anonymous version of the adage is that "we must learn the lessons of history twice because no-one was listening the first time"*
71 *Bushell, E.J., The Never Ending Story of Airworthiness versus Murphy's Law, November 2007*
72 *Human Resource Management, Hartel, C.E.J, Fujimoto, Y., 2nd Ed, Pearson, 2010. p.85-86*
73 *Skills Australia, Defence Industry Workforce Strategy, Discussion Paper, January 2012, p.34*
74 *Op cit (AWPA) p.120*
75 *Deloitte Touche Tohmatsu, The Graying Government Workforce, 2007*
76 *Interview with Defence PSE worker, Monegeetta, Victoria.*
77 *Op cit (Skills Australia Defence Industry Workforce Strategy) p.33*

SECTION 7
SUPPORTING THE DEFENCE OF AUSTRALIA - THE FORCE BEHIND THE FORCES

> Defence will continue developing new approaches to differentiating the employment offer at both a group and individual level, so that the retention of those who are critical to capability, and actively being sought for civilian employment, can be assured. Critical employment areas will be addressed through a well-targeted package of cost-effective measures embracing both financial and non-financial elements of the employment offer and taking into account the tight fiscal environment.[78]

Australia needs a viable and sustainable Defence organisation in order to support the Australian Defence Force. History has shown that in times of greatest need, systems, equipment and the people required to provide a sustained effort on our collective behalf are in short supply. As a nation we must always be in a position to produce people with the know-how to keep things going in the event that we are required to 'go it alone'. The ability to understand our technological environment is essential for good decision making, and is a key ingredient in ensuring the best possible value outcome in the good times and the bad.

In order to ensure a viable and sustainable Defence environment, Australia requires people with the skills and experience to acquire, produce, repair and maintain critical systems – this requires a balanced mix of skilled tradespeople, technicians, professionals and semi-professionals. Over time, the growth of an individual's knowledge and experience allows them to move upwards through the value chain, with the gap left to be filled by others moving up from below. As a result, workforces exist as a dynamic system, rather than a mass of available labour.

The Defence workforce, uniformed and civilian, is not a 'plug and play' device.

The current Physical Sciences and Engineering workforce system is out of balance. There are too many skilled workers nearing retirement age with a decreasing number of candidates to fill their shoes. This is due partly to a reducing number of opportunities to access entry level training in the public sector, as well as fluctuating demand in others. Unchecked, the steady atrophy of comprehension within the ranks of the APS will mean that the Australian Defence Organisation will become inexperienced, inadequately skilled, insufficiently dexterous, and unable to exercise the judgment to know whether acquisition and sustainment decisions represent good value or not. This places us a long way from our 'clever country' tag.

The Defence Physical Sciences and Engineering workforce has been steadily degrading due to a general malaise in relation to investment in strategic skills, and an increasing infatuation with out-sourcing to fill the gaps. Whilst the Defence industry may be capable of filling these gaps, the risk of not having a Physical Sciences and Engineering workforce available where and when they are needed is too great. We must have a dedicated workforce with the range of skills, knowledge, experience and security clearances to be trusted custodians of leading edge military technologies. We need a workforce of technically savvy people with the commercial acumen to not only understand, but make smart decisions based on realistic expectations, to ensure maximum bang for the taxpayer buck.

A regular consequence of efficiency dividend seeking is recruitment freezes and reductions in training expenditure, as these pose the least visible risk to meeting operational outcomes – but it is a false economy.

Failure to invest in training slows the progression from competence to expertise, increasing the likelihood of skill and knowledge gaps appearing throughout the system. Failure to recruit to fill vacant positions increases pressure on remaining staff, has a similar inhibitive effect on career progression, and increases staff propensity to leave. Whilst a reduction in staff wages is interpreted as a positive outcome against financial performance indicators, the erosion of know-how and capacity to deliver in an unstable environment goes largely unconsidered.

The economic reality that governments cannot, and should not, rely on commercial interests to carry unnecessary overheads on its behalf means that the Defence Physical Sciences and Engineering will, in some instances, have sole responsibility for capability continuity. Unless Defence has a balanced, harmonised workforce plan, the ability to deliver required Physical Sciences and Engineering services in perpetuity may

grind to a halt as the ageing workforce departs.

In terms of ability to cope with fluctuating workforce demand, Defence runs a distant third to the mining and energy sectors. Competition for Physical Sciences and Engineering skills, experience, and judgment is fierce, and Defence is competing with industries whose shorter planning horizons and deeper pockets make them front-runners. Unless Defence is prepared to invest in training and skills retention in order to maintain long-term continuity, the Commonwealth is faced with paying an inflated market price as demand for skilled people outstrips supply.

In commercial terms, whilst a lead time of around 15 years to restore workforce knowledge gaps may represent a missed business opportunity, in Defence such gaps could have catastrophic consequences in terms of military vulnerability, ADF personnel safety, or spectacularly expensive project failures – none of which are tolerable in terms of our obligation to the people of Australia.

The cost to regain deep specialist expertise, once lost, is also often underestimated, and exposes Australia to the risk of being 'caught with its pants down' when it can least afford it. The well-documented 'valley of death' created by the 2012 Defence Capability Plan, and consequent implications of skilled workforce losses and shipyard closures, suggests that Australia will be unprepared, and unable, to meet its own demand from 2020 onwards, regardless of best intentions to do otherwise. In the worst case, we, as a nation, will have to face the difficult decision to either send work we could do ourselves offshore, or accept a reduction in our ability to protect ourselves and our interests: a second-order effect of the first option is an increased trade deficit, increased foreign debt, and lost opportunity to invest in ourselves.

In order to ensure quality supplies are produced, and the quality of the supplies can be properly assessed, both sides of the Physical Sciences and Engineering ledger must balance – this means that on the one hand, Defence industry must be capable of delivering quality product and on the other, the Defence Physical Sciences and Engineering workforce must be capable of applying skills, dexterity and judgment to make good, informed, and balanced decisions.

Maintenance of a balanced workforce system requires investment. In order to keep the process robust and viable, we must accept the requirement to maintain levels of expertise over time, and acknowledge that ongoing investment in growing skilled and experienced tradespeople, technicians, semi-professionals and professionals is the only way of ensuring this occurs.

78 *Op cit (Defence Portfolio Budget Statement 2014-15), p.23*

RECOMMENDATIONS IN DEFENCE OF NATIONAL SOVEREIGNTY

Sovereignty is the ability of a nation to manage its own affairs, free from the influence of other nations, individuals, or business interests. A nation's ability to defend itself on its own terms, in support of the things that make it unique, is fundamental to achieving that aim.

This booklet argues for the maintenance of national sovereignty, in part through a vibrant and effective Defence Physical Sciences and Engineering workforce. Unlike other elements of the Australian Defence Organisation, this workforce is responsible for ensuring Australia remains at the leading edge of Defence technology, and that we are the trusted custodians of the best possible technology available. It is a workforce of technicians, tradespeople, engineers and scientists whose common goal is enabling Australian Defence Force personnel to do their difficult and dangerous jobs efficiently, effectively and, most important of all, safely.

The defence of Australia, the security of its assets and interests, and the preservation of its way of life has – rightfully – long been afforded priority by both sides of politics. As a middle power, we have earned a reputation globally for standing up for what we believe in, and we are prepared to 'put our money where our mouth is'. Australia's principles must not be subordinated by pursuing short term economic goals (such as a rapid return to Budget surplus) at the cost of ongoing investment in our ability to defend ourselves. This is not to say that economic management is unimportant, just that it must be weighed against other significant considerations.

What is needed

The appropriate priority should be assigned to the defence and security of Australia.

Those functions relevant to Defence which are to be performed by the ADF, the Defence public service and private contractors should be clearly delineated. Regardless of the proportions, specification of Commonwealth requirements and quality assurance of delivered materiel/ services must remain in Commonwealth hands.

Once the functions to be performed by the civilian arm of the Department of Defence have been identified, a workforce of sufficient numbers, with the competencies appropriate to exercise Commonwealth authority in a responsible manner, must be maintained. The monetary value of Defence materiel, and its importance to the preservation of our way of life, demands it.

The role of the Defence Physical Services and Engineering workforce, and the skills, knowledge and experience which it brings to that role, must be acknowledged, understood and respected by workforce planners, Defence policy drafters, senior managers and politicians alike. This is not a 'plug and play / one size fits all' workforce that can be readily switched on and off as financial conditions fluctuate.

The availability of these skills, knowledge and experience needs to be preserved into the future. This requires a clearly defined career path

LHD being finished in Melbourne

Collins submarine

> The capacity of Australia's Defence industry to grow, attract and retain specialist skills and build on these skills through upskilling and reskilling is crucial to the competitiveness of this industry. Organisations competing for Defence procurement contracts require a balance of professional, trade, technical and managerial skills, and an ongoing commitment to skills development and upskilling to ensure the currency of these skills.[79]

supported by structured training for existing employees and a regular intake of entry-level employees, such as apprentices, technical trainees and professional cadets, who can be mentored by those who have long been in the system and may be approaching retirement.

Each member of the Physical Sciences and Engineering workforce should be employed to the level of their competence, so that their training and experience is not wasted and they do not become disaffected through under-employment. As the (then) Skills Australia observed: "(T)here are overlaps between the work undertaken by technicians, and work undertaken by professional engineers, and the two groups commonly 'compete' to perform the same work…This overlap in skills can be used by Defence organisations to improve the utilisation of skills and boost productivity." [80]

The workforce should enjoy fair rates of pay and conditions of employment, rates and conditions competitive with the market for their occupations. Bargaining with them should be conducted in good faith.

What is not needed

The role of government should not be continually denigrated, such that public service is dismissed as mere bureaucracy and a drain on public coffers. Such a caricature ultimately undermines the integrity of Australia's defence, as addressed elsewhere in this booklet.

Certain functions should not be out-sourced from the public sector, because to do otherwise would compromise transparency and accountability. Others should not be out-sourced, because they underpin public safety or because their retention within the public sector provides value for money. Not all government functions are compatible with the profit motive.

Public employees, regardless of their functions and the value they give to the community, should not be characterised as 'pen pushers' or the other pejoratives commonly thrown their way. For one thing, they perform a multitude of functions, not just at desks, but also in laboratories, on

79 *Skills Australia, Building Australia's Defence Supply Capabilities, 2012, p.7.*
80 *Ibid, pp.12-13.*

military bases, at sea, in the field and on proof and experimental ranges.

Workforce planning and occupational training should not be allowed to atrophy, such that progressively greater reliance must be placed on the poaching of trained employees from other employers – or from overseas – and/or the further outsourcing of work to the profit-seeking sector.

The public sector workforce should not be used as the test-bed for the industrial relations policies of the government of the day.

'Productivity' should not be willfully confused with cost-cutting such as to camouflage attacks on the working conditions of employees.

A case study of what is not needed?

The Australian Government has issued a workplace bargaining policy.[81] It explicitly applies to the Australian Public Service (APS) as a whole and to government agencies. Compliance with it is overseen by the APS Commission and, where necessary, the Department of Finance.

That bargaining policy foreshadowed the mandating of APS-wide, legally binding work level standards, which describe the functions and associated work value at each level of the classification structure.[82] Such standards were mandated in December 2014.[83] By definition, they are generic rather than tailored to the needs of individual Departments and agencies, many of which are predominantly administrative in nature and have office-based workforces and only a minority of which practise engineering and science.

The Department of Defence's collective agreement[84] nominally expired in June 2014. Discussions to replace it commenced in late September 2014. Such discussions have been heavily constrained by the government's bargaining policy.

During the discussions, Departmental representatives have:

- proposed to replace a section of the current agreement headed 'Support for Occupational Disciplines Critical to Defence Capability' [85] with an individual flexibility arrangement;
- declined to update an annex within the current agreement which commissioned a review of certain functions of the Physical Sciences and Engineering workforce,[86] such that the annex now address remediation of the problems identified by that review;[87] and
- proposed to remove from the current agreement a section which calls up the Defence Classification Manual and its work level standards,[88] when one of the two classification streams that the manual recognises is specific to the Physical Sciences and Engineering workforce.

By mid-February 2015, more than 19 months after the last general pay rise made to its civilian workforce, the Department had not made a pay offer of any sort. It was still awaiting approval to do so from the APS Commission. (In November, the Defence Force Remuneration Tribunal had, with the support of the government, awarded military personnel a pay increase of only 4.5% over three years, an increase below the rate of inflation. It had also endorsed the withdrawal of certain benefits previously enjoyed by the military.)

> "We're going to see restraint across the whole of the public sector and I would be very surprised if anyone in the Commonwealth public sector receives more than is received by our Defence Forces."[89]

> "(A)t the end of the day a job, even with a frozen wage, is a lot, lot better than no job at all."[90]

The policy being enforced in February 2015 was not what was needed to sustain a viable Defence Physical Sciences and Engineering workforce. It sought to shoe-horn that workforce into a one size fits all approach, together with employees in for example the Australian Taxation Office and the Plague Locust Commission. It was further compromising Australia's ability to maintain its Defence capability and, therefore, its national sovereignty.

Lest there be any doubt, this booklet is not about pay rises or collective bargaining, although these are relevant to the matters it addresses. Rather, it is about the survival and long-term integrity of the Defence Physical Sciences and Engineering workforce – the force behind the Forces.

81 *Australian Public Service Commission (APSC), Australian Government Public Sector Workplace Bargaining Policy, March 2014, available at: http://www.apsc.gov.au/aps-employment-policy-and-advice/workplace-relations/2014-workplace-bargaining-policy*
82 *APSC, APS Work Level Standards, September 2013, available at: http://www.apsc.gov.au/publications-and-media/current-publications/worklevel-standards*
83 *APSC, Circular 2014/4 – Amendments to the Public Service Classification Rules 2000, available at: http://www.apsc.gov.au/publications-and-media/circulars-and-advices/2014/circular20144*
84 *Defence Enterprise Collective Agreement 2012-2014 (DECA), available at: https://www.fwc.gov.au/documents/documents/agreements/fwa/AE893129.pdf*
85 *Ibid, p12.*
86 *Ibid, p124.*
87 *Op Cit (Deloitte)*
88 *Op Cit (DECA), p.10*
89 *Prime Minister Abbott, as quoted in an item published by Workplace Express, an electronic subscription service for industrial relations practitioners, on 5 November, 2014*
90 *Senator Eric Abetz, Employment Minister and Minister Assisting the Prime Minister for the Public Service, as quoted by Workplace Express in an item of 12 September 2014.*

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