10 YEARS OF CREATING FUTURE DEFENCE CAPABILITY

DMTC

ANNUAL REPORT 2018

IMAGE CREDITS

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AUSTRALIAN INDUSTRY GROUP
Page: 5.

SUTTON TOOLS
Page: 32.

UNIVERSITY OF WOLLONGONG
Pages: 10, 54.

UNSW CANBERRA
Page: 40.

UNSW SYDNEY
Page: 55.

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CONTENTS

MINISTERIAL Foreword

Australia's defence industry has a critical role in safeguarding national security interests, ensuring the Australian Defence Force (ADF) is equipped and ready to carry out the operations and tasks set for it by the Government.

The Australian Government's unprecedented $200 billion investment in our defence capability across the next decade is an opportunity to develop Australia's defence industry into an international powerhouse. Growth of the Australian defence industry will benefit not just the military but also be a major contributor to our economy.

Our new platforms will be the flagships of Australian defence capability for decades to come, and so need to be designed to meet not just today's challenges, but also the emerging threats of the future. Therefore, harnessing the most innovative, cutting edge technologies and solutions that Australian industry has to offer is critical to ensuring the ADF continues to enjoy the capability edge in the region.

The Defence Materials Technology Centre (DMTC) has unique capabilities and networks to bring to the tasks of supporting and enhancing ADF capability and building a sovereign Australian industrial base. Its work in the pre-competitive phases of technology development is vitally important to realising the goals articulated in the Defence Industry Policy Statement (DIPS) and Defence Industrial Capability Plan.

Working in conjunction with the Defence Innovation Hub and the Next Generation Technologies Fund, DMTC has supported positioning the Australian industry and innovation sector to meet Defence's capability and capacity demands into the future.

Recent decisions on future frigates and combat reconnaissance vehicles are examples of how the Government's investments will deliver the platforms and capabilities needed by the ADF while also creating jobs, benefiting Australian businesses, and boosting the national economy.

The land, sea, air and joint capabilities to be introduced are as significant a challenge for the national industrial base as they are for Defence in how to acquire, develop, operate and sustain them. With the Defence customer and industry partners engaged at every stage, DMTC's model helps ensure that the vital practical aspects of how technologies will be applied, produced, integrated and maintained are not overlooked.

Guided by the challenges articulated by Defence, DMTC's best practice collaborative approach is being applied to a widening span of technology areas. As always, these efforts are underpinned by brilliant Australian research.

Effective collaboration between government, research and industry sectors is a fundamental driver of innovation. To its great credit, DMTC has proven to be both a leader and an exemplar of successful technology development and innovation in the defence and manufacturing sectors.

We look forward to the continuing relationship between Defence and DMTC and its track record of success sustained in the future.

Through its many programs of work – some of which attract headlines while others continue apace without earning the same attention – the DMTC community has boosted Australia's defence capabilities and, in so doing, has added to the security of our nation.

We also pay tribute to DMTC and its partners on reaching the milestone of 10 years of work to enhance Australia's defence and national security. In this regard, this report is not only testament to activities undertaken in the financial year past, but to sustained effort over a decade that has laid the groundwork for today's successes.

We congratulate Mark Hodge and his DMTC team for their continuing role in what we believe is a great national enterprise and endeavour.

THE HON. CHRISTOPHER PYNE, MP
Minister for Defence

THE HON. STEVEN CIOBO, MP
Minister for Defence Industry

KEY MESSAGE
Industry

ANDY KEOUGH CSC

Chair, Australian Industry Group Defence Council

The first two decades of this present century have been highly disruptive for Australian manufacturing. We have had to contend with the local impacts of global shocks, and the rapid pace of technological change. The defence industry sector is certainly not immune from these challenges, and faces some unique pressures of its own. Workforce and talent constraints, the onset of the digital age and the demand for 'low volume but high value' manufacture have arguably challenged the defence sector more profoundly than other sectors. The Industry 4.0 revolution is well and truly upon us, and in some cases there has been a slowness to understand, adapt and adopt new methods.

Organisations like DMTC are fundamental enablers of the success of businesses large and small across the Australian defence sector.

Excellence in manufacturing is dependent on innovation and collaboration, and these have consistently been the hallmarks of DMTC's approach over the past decade. The careful and deliberate balance of DMTC portfolio of activities across the research and development continuum has allowed for the transfer of knowledge and expertise from academia and government research laboratories to the factory floor, all with an unfailing focus on the Defence end-user.

The announcement of the Future Frigate tender decision in June represented the next step in the transformation of Australia's defence industry, underpinned by the Australian Government's defence industry policy commitments. The shift in defence industry policy represents a generational change and opportunity for Australian industry in this country. The Defence Council has been and will continue to be a strong supporter of the policy and of DMTC, and was delighted with Minister Pyne's commitment to the continued support of both.

DMTC has partnered with many Defence Council member companies and will, of course, continue to work closely with Defence and with the successful Future Frigate bidder, BAE Systems Australia, to continue to build domestic capability and the capacity of domestic supply chains. Across many of the Defence domains, the collective expertise of the industry and research partners collaborating with DMTC has ensured a broad knowledge base through which world-class and industrially-relevant outcomes can be achieved.

By brokering and delivering innovative solutions to complex technological challenges, DMTC has proven to be the kind of trusted partner that Defence and Australian industry needs.

I welcome this Annual Report and commend Tony Quick and Mark Hodge and the DMTC community at large for their substantial contribution over the past decade.

Pictured: Australian Army soldier, Private Thomas Reid, a member from Task Group Taji-7 Force Protection at the Taji Military Complex, Iraq.

CHAIR'S Report

MR TONY QUICK

Chair, DMTC

In 2018 DMTC has celebrated a decade of success in delivering on its mission. Great credit is due to all involved in envisioning a path to future success, and dedicating their efforts and considerable professional expertise to the task.

While there is much to celebrate, there is little time or room for complacency. DMTC continues to build and grow through extensions of work with existing partners and the development of new activities.

The Board welcomes new partners and looks forward to their involvement and positive contributions. Growth in the number and diversity of industry and research partners is very welcome, and has continued beyond the close of the reporting period.

Since its establishment, DMTC has sought to continually improve and align our engagement with Defence and our industry and research partners to ensure we remain relevant and consistent with policy settings and business environment of the day.

Throughout this constantly evolving environment, DMTC's focus has been consistently underpinned by the effectiveness of its collaborative model. This is central to our success and requires that we continue to deliver benefits to each of our stakeholder partners across the range of activities we share.

The Board of Directors has continued to set high expectations in terms of governance, financial management and programmatic outcomes and remains firmly of the belief that these are critical foundations to achieving the strategic goals of DMTC and its partner organisations. It's a credit to Mark and his management team that these expectations are met and exceeded.

The Board has been pleased to see DMTC's work highlighted by our industry partners and receiving prestigious national awards. The Board views these public acknowledgements as important validations of the value DMTC provides across the sector, and to both our research excellence and industrial impact in equal measure.

In reflecting on the significant anniversary that we celebrate this year, I would like to recognise the outstanding contributions of all past and present Board members. I would like to particularly thank John Norrish who retired at the 2017 AGM and Roger Lough, Bronwyn Constance and Peter Jonson who will retire at the 2018 AGM. They will all be greatly missed. While all Directors bring valuable and unique skills and perspectives we have, together, achieved strong consensus and a resolute focus on positive outcomes for members, stakeholders and customers and we are confident this will continue.

It is my great pleasure to present the DMTC Annual Report for 2018.

CEO'S Report

DR MARK HODGE

CEO, DMTC

DMTC has a strategic and important role in the Defence innovation system that was envisaged in the landmark 2016 DIPS.

As a company, the words capability through collaboration are a great way to sum up our strategic intent. In the context of reaching as significant a milestone as our 10th year of operation, it's also a useful way to reflect on our activities.

Looking back on my first message to the DMTC community in 2008 I wrote that:

> *"DMTC's industry participants are our primary audience … by providing the pathway to enhanced capability they differentiate DMTC from many other research programs that stall for want of commercial opportunity."*

I stand by that statement to this day. It has served us well, as has the continued guidance from Defence on the strategic framework and direction under which we support defence industry.

I am immensely proud of the DMTC team for its determined adherence to our collaborative business model. Our industrial partners rely on it, and frequently remark just how much they value it. Our research partners rightly take a lot of credit for their role in it. Most importantly, our Defence customer is the ultimate beneficiary of it. We must never, and never will lose focus on the mission of delivering for each of these stakeholder groups, as our model of collaboration simply doesn't work unless each group remains strongly engaged.

We are resolutely focused on building the capability and capacity of Australian industry to support Defence objectives, particularly the broad base of small to medium enterprises (SMEs) that are so critical to the effectiveness of supply chains.

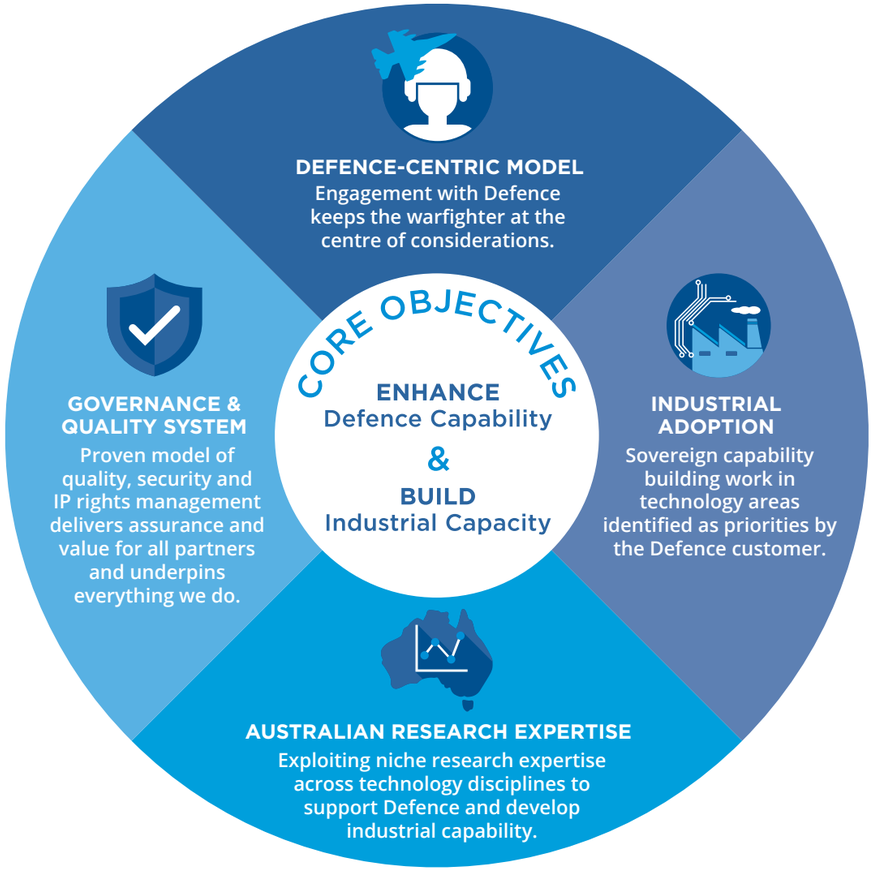
Over 85 percent of our collaborations involve more than one research partner and a significant majority involve more than one industrial partner. We are pleased to work with Defence, and proud to play our part in realising the objectives of the Force Design Division, the Next Generation Technologies Fund, the Defence Innovation Hub and the Centre for Defence Industry Capability as key elements of the Defence Innovation System envisaged in the 2016 policy. This is the innovation pipeline in action.

'Looking back to look forward' is about learning from both our successes and our missed opportunities. It's about a commitment to quality and improvement that goes far beyond lip-service. It's also about reflecting on our determination to keep the warfighter at the centre of our considerations, and redoubling that commitment in the years ahead. We're delighted of course with the continued support and commitment of Defence as we work through the detail of our next enabling engagement, alongside our various platform programs which are proving time and again the impact of our model.

This Annual Report seeks to recap on the activities that were conducted across the 2017-18 financial year, while also highlighting just a few of the exemplar projects across our decade of achievements. The fact that there are simply too many to name is a great tribute to the work and endeavour of the DMTC team, and the DMTC community at large.

I commend the Report to you.

10 YEAR ANNIVERSARY
Highlights



BY THE NUMBERS

$125 Million +	Sector investment achieved as a result of enabling Defence relationship
500+	People engaged in DMTC project teams around Australia at any one time
10	National awards for capability enhancements
300+	Technologies transferred to industry
80+	Industrial partners
40+	Australian SMEs engaged in industry capability development or capacity building programs
48	PhD scholarships
20+	Research partner organisations
115	Collaborative projects

HIGHLIGHTS FOR DEFENCE

DMTC ACTIVITIES*	TECHNOLOGY DEPLOYMENT / DEFENCE CUSTOMERS
Enhancements to soldier protection	LAND 125 Phases 3 and 4, Land 2110 and Land 3025
Modernising naval ship fabrication technologies, expertise in corrosion	SEA 5000, SEA 4000, CN10 (Collins Sustainment) and Naval Shipbuilding Enterprise
Optimised aerospace fabrication technologies	Air 6000 (JSF), CAF02 Hornet Sustainment and CAF03 Lead-In Fighter
Battery & fuel cell technologies	LAND 125 Phase 4
Expert studies of Australian industrial capacity	SEA 5000 and Naval Shipbuilding Enterprise
Vehicle-borne protection and fabrication	LAND 116 (Bushmaster) and LAND 121 Phase 4 (Hawkei)
Medical Countermeasures	Joint Health Command

*Examples only

OUTCOMES FOR INDUSTRY

DMTC PLATFORM TECHNOLOGIES*	PRIMARY DEPLOYMENT DOMAINS
Automated offline programming (robotics)	Land and Maritime
Low-distortion welding techniques	Land and Maritime, Supply chain development
CNC machining	Air and Space, Supply chain development
Composite material development	Land, Maritime, Air and Space
Precision tooling	Air and Land
Additive manufacture and repair techniques	Air, Maritime and Space

*Examples only

10 YEAR ANNIVERSARY
Highlights

Leveraging expertise and capability from a range of partners including the University of Wollongong (UoW) (pictured above), DMTC is developing innovative and highly efficient offline programming systems to enable robotic welding to be applied to highly-complex but typically low-volume defence equipment orders.

NOVEL CONFORMAL ANTENNA STRUCTURES

DMTC has achieved significant technical breakthroughs across the decade, working alongside founding partners including Thales Australia, Defence Science and Technology Group (DST), the University of Queensland (UQ) and RMIT.

One area of technology development that has spanned DMTC's years of operation is the integration of communications system capabilities into load-bearing structures.

Initially designated for application to military aircraft and surface ships, the more recent focus of this work has been on protected mobility vehicles. Conformal antennas remove or reduce the need for structures to protrude from the vehicle. Benefits include reductions in weight, the likelihood of damage and vehicle signature.

When integrated into a structure such as a vehicle bonnet, a composite antenna material must both support load and guarantee reliable functional performance. DST in collaboration with Thales developed structural antenna systems based on glass-fibre reinforced composite laminate, using different methods to produce conductive elements utilised in conformal radio-frequency antenna structures.

Interfaces between the different material layers constitute potential weak-spots that could compromise durability and performance. DMTC's research team with UQ as primary research partner has led the development of experimental methodologies to determine the fracture toughness of these interfaces.

Numerical simulations are then used to support the design of optimised antenna systems and predict failure rates. Shock loading experiments have confirmed the antenna's structural integrity during severe loadings.

Antenna prototypes have now been successfully installed and trialled on a Thales protected mobility vehicle and performance data collected to date has validated the potential benefits of this work and provided valuable insights into areas for further research.

Pictured right: The Hawkei Protected Mobility Vehicle – Light, two and four-door variants at the Taji Military Complex, Iraq.

10 YEAR ANNIVERSARY
Highlights

PATHWAYS TO SUCCESS

DMTC's successful intellectual property (IP) model provides clear pathways for industrial project partners to pursue Australian and export opportunities through rapid, royalty-free transfer of IP use rights.

Our decade-long development of a composite forming technology for armour manufacture, known as double diaphragm deep drawing (D4), is an excellent example of this model in action.

D4 offers a range of process and performance enhancements over other composite forming technologies for manufacturing including:

- the ability to curve armour without cutting (splicing) fibres
- adoption of next-generation materials reduces weight of a combat helmet to 30 percent of the conventional alternative with comparable or improved protection performance
- significant reductions in manufacturing cycle times – can be made in one-eighth of the time.

DMTC owns the IP rights and holds an Australian Innovation Patent for the D4 technology. Consistent with its mandate, DMTC aims to maximise beneficial outcomes for both the ADF and Australian defence industry through adoption and commercialisation of this exciting new platform technology – by multiple industrial partners in Australia – along different proprietary pathways and technology extensions.

To date, this has culminated in licence agreements with several industry partners including DefendTex, The Smart Think and Marand Precision Engineering, each of whom are pursuing market opportunities with specific, discrete elements of the technology.

It is expected that further opportunities to advance the D4 technology in new directions for defence, commercial and export markets will arise in the future.

Several partners have collaborated on the project over the past 10 years, including Deakin University, Ballistic and Mechanical Testing, DefendTex, The Smart Think, Australian Defence Apparel, VCAMM, Pacific ESI and DST.

> "DMTC efforts in this area not only contribute to the protection of our personnel but also support Australian defence industry by optimising manufacturing techniques which keep Australian industry competitive on the world stage."
>
> **Major General (Rtd) Jeff Sengelman DSC, AM, CSC**
> **formerly Head Modernisation and Strategic Planning - Army**

PROFESSOR JOHN NORRISH

As part of its 10-year anniversary celebrations, the DMTC Board has recognised the notable contributions of three of the founding directors of DMTC, Emeritus Professor David St John, Dr Peter Preston, and Emeritus Professor John Norrish, with inaugural DMTC fellowships. On behalf of the fellows, Emeritus Professor Norrish shares his reflections on successes achieved in DMTC's first 10 years of operation.

This year we are celebrating the formal 10-year anniversary of DMTC, but in fact the activity to form the DMTC started in August 2007 when the Australian Government announced a new investment in future Defence technology.

David St John, who at the time was CEO of the CAST Cooperative Research Centre, noticed the call for proposals and initiated discussions with several potential partners including the UoW and I. In just a short few months, a broad group of credible partners signed up and a detailed research plan was mapped out. Our proposal was then submitted to Defence and was ultimately successful.

Work started in earnest in mid-January 2008 and there was still much to do, not least of which to establish the overarching governance structure. In early May the Board considered several high-calibre candidates and selected Mark Hodge as CEO. This was at the time, and has proved to this day, to be an unquestionably good choice.

Having been involved in other similar organisations I believe DMTC is an outstanding example of an organisation focused on outcomes for its customers, and of a Board focused on working for the benefit of its stakeholders.

During my 10 years as a director, the DMTC Board has maintained high standards of governance, has steered the strategy of the organisation to ensure it satisfied its remit to its members, and has evolved and grown beyond the expiry of its initial contract term.

Personally, I consider that I have been privileged to belong to this Board and it was particularly gratifying for me to see many of the envisaged research outcomes being realised and adopted by the defence industry partners.

My involvement in the DMTC journey has sometimes been challenging, but always rewarding. I am sure David and Peter Preston would say the same. The organisation is going from strength to strength, and can expect a very healthy future.

The acknowledgement from DMTC in awarding the inaugural DMTC Fellowships to David, Peter and I for our part in this adventure was very generous and much appreciated.

VALUES

Inclusive
Committed
Inspiring
Trusted
Integrity

Our VISION

To provide technology solutions enabling industry to enhance Australian Defence and national security capability.

Our MISSION

DMTC creates and enhances Australian industrial capability by leading, facilitating and managing collaborative research and development and innovation activities in the defence and related sectors in manufacturing, engineering and applied science. The Defence and national security customers, industry and research sectors are key stakeholders.

Our PARTNERS

DMTC is comprised of partner organisations that contribute resources towards applied research and development activities.

By working together in a collaborative environment, our partners achieve far greater technology and performance outcomes more quickly and cost-effectively than by pursuing research and development activities independently.

Pictured left: Ultra-high-strength steel deposits are used in validation and verification testing for structural restoration for aerospace applications.

DMTC leads collaborative projects to advance technologies and develop industrial capabilities in the Australian defence and national security context.

Our programs enhance ADF capability and operate on a co-investment model, an approach that allows each partner to leverage the expertise, financial resources and capabilities of the other partners. This genuinely collaborative model provides the pathway to creating industrial capability and solving complex challenges.

DMTC plays an important role in building a more capable and defence-ready industry sector. DMTC has a strong focus on engaging SMEs in its research and development activities and equipping them to participate in prime contractors' supply chains.

Collaborating through DMTC presents opportunities for our research and industry partners to access world-class expertise, contribute to collaborative projects and leverage outcomes in areas of specialisation or potential technological breakthrough for their organisations.

The research sector, including government research agencies such as CSIRO and ANSTO, universities and private research institutions, receives significant financial and non-financial value through DMTC. The early identification of capable industry partners validates the industrial relevance of research themes and ensures a clear path to adoption and commercialisation, and students have the opportunity to gain practical insights and relevant industry experience.

DMTC contracts with Defence and national security customers, industry and the research sector, and applies a consistent and ISO 9001 accredited model for project definition, management and delivery. This standardised approach removes an administrative burden for our partners, allowing them to direct all resources to realising project outcomes.

The involvement of the Defence customer ensures ongoing relevance to the Defence end-user, and the company has built a strong reputation with its Defence customer for solving complex technological challenges.

DMTC collaborations typically involve multiple partners, a model that is made possible by a focus on the pre-competitive stage of technology development. DMTC's IP model aligns closely with the Defence Innovation Hub's IP Strategy. IP is controlled at the individual project level. Ownership of all background IP remains with the relevant partner and all project partners retain automatic rights, within agreed fields of use, to practise IP that is developed (or advanced) during the project. Fields of use for IP developed through DMTC projects are negotiated with partners prior to project commencement.

In addition to its enabling relationship with the Defence Innovation Hub, DMTC continues to work across the broader Defence Integrated Investment Program to deliver beneficial outcomes to Defence's Capability Managers. DST, the primary scientific adviser to Defence, is a DMTC partner and directly supports many DMTC projects.

In enhancing Australian industrial capability, DMTC activities also represent a contribution to the success of other Defence initiatives and enabling frameworks, including the Sovereign Industrial Priorities, Global Supply Chain and Defence Export advocacy programs.

ABOUT US
DMTC

Technology Readiness Levels (TRLs) offer a standardised numerical indicator for the maturity of a technology. TRLs provide a common language to describe the status of a technology in development ranging from the initial identification of an idea or opportunity through to a fully tested product that is ready for market.

DMTC applies a structured methodology to conducting Technology Readiness Assessments (TRA) and documenting the TRL of the technology in question. TRAs are conducted at the outset of the project activity, at each major project review or milestone and at project completion.

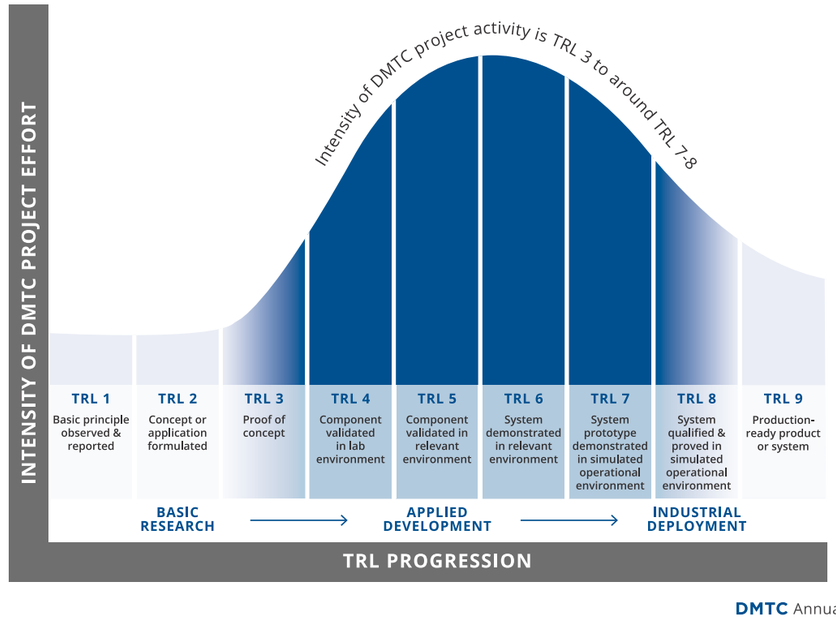
Historical data (as illustrated below) indicates that the bulk of DMTC activity falls within the range of TRL3 to TRL8, capitalising on and extending basic or fundamental research for which Australia rightly enjoys a positive reputation.

This provides an exemplar of the benefits of the 'single innovation pipeline' envisaged in the 2016 DIPS, with DMTC working alongside DST, CSIRO and the university sector to apply early research outcomes and progress them towards industrial adoption.

DMTC's best practice approach to program development is resulting in smarter engagement with prospective industry and research partners, faster transition from development to implementation and more strategic deployment of resources.

DMTC recognises that the early phases of a technology development activity are often the most critical to long-term success. Particularly in areas where the technical risk is judged to be high, initial scoping studies are increasingly being used to test underlying assumptions about the trajectory of technology development. Mitigating technical risk in this manner is critical in the demanding defence environment and provides clarity in investment prioritisation. These studies are also a useful way to scrutinise existing technical solutions, benchmark current Australian industry capability and identify partners for follow-on projects.

Better foresight and definition of the potential technical breakthroughs that can be made, and the attendant risks in moving along the TRL pathway, help to inform better decision-making and make more accurate estimates about technology development milestones.



TECHNOLOGY
Themes

YEAR IN SUMMARY

	Identification and/or selection of alternate materials	Miniaturisation	Additive Manufacturing	Simulation & Validation	Smart Sensors	Power & Energy Systems	Corrosion & fatigue management	Textiles & Fabrics
ENABLING TECHNOLOGIES PROGRAM								
Lightweighting	✓	✓	✓	✓			✓	
Hybrid composite materials	✓	✓	✓	✓	✓	✓	✓	✓
Industry 4.0 capabilities for SMEs			✓	✓	✓			
AIR PROGRAM								
Challenges in characterisation and corrosion of light metal alloys	✓						✓	
Sustainment of emerging materials			✓				✓	
Wire arc additive manufacturing – aerospace and space components				✓	✓		✓	
Additive manufacturing – componentry	✓		✓					
LAND PROGRAM								
Blast System Modelling	✓			✓				
Automated Manufacturing				✓	✓			
Fuel cell technologies for military land vehicles	✓	✓		✓		✓		
Alternative materials characterisation	✓		✓			✓	✓	
Advanced nanostructured fabrics	✓	✓		✓	✓			✓
Soldier protection system - concepts		✓		✓	✓	✓		✓

	Identification and/or selection of alternate materials	Miniaturisation	Additive Manufacturing	Simulation & Validation	Smart Sensors	Therapeutics, Vaccines & Diagnostics	Corrosion & fatigue management	Textiles & Fabrics
MARITIME PROGRAM								
Blast modelling and life of type (LoT) assessment	✓			✓			✓	
Corrosion prognostic health monitoring	✓	✓			✓		✓	
Low distortion welding	✓			✓			✓	
Additive manufacturing-maritime components	✓		✓		✓		✓	
Single-crystal piezoelectric ceramics	✓	✓	✓		✓			✓
HVOF coating technology	✓						✓	
MEDICAL COUNTERMEASURES PROGRAM								
Antivirulence compounds	✓					✓		
Handheld diagnostic device					✓	✓		
Pathology lab-on-a-chip			✓		✓	✓		
Evaluation of film array warrior panel	✓					✓		
Rapid diagnosis of microbial infections		✓			✓	✓		
HIGH ALTITUDE SENSOR SYSTEMS PROGRAM								
UAV reflectometry		✓		✓	✓			
Compact, spatially agile spectral sensors				✓	✓			
Scoping study – feasibility of Ka-band or Teraherz Receivers		✓		✓				

MARITIME

DMTC personnel install an HVOF-coated hydraulic actuator on the flight deck of HMAS *Canberra*. This field trial, involving the installation of stanchion piston rods with HVOF and APS coatings, is expected to demonstrate enhanced corrosion protection and minimised surface degradation.

A focus on advancing new technologies and building Australian industry capacity is needed if the goals of the Naval Shipbuilding Plan, released by the Australian Government in 2017, are to be fully realised.

The continuation of DMTC's decade of work on technologies relevant to Naval Shipbuilding Enterprise and repair is funded by Defence's SEA 5000 Program Office, but is concentrating effort and attention on technologies that can be adopted and utilised in a range of programs across the shipbuilding enterprise.

DMTC's role to deliver industrially-ready and relevant technology outcomes for the sector involves coordination with the overall Defence S&T Plan and close collaborations with a range of stakeholders including Defence, industry primes and SMEs and research institutions.

These stakeholders are working with DMTC to deliver breakthroughs and innovations in manufacturing, to develop and integrate new cost-effective technology and to enhance skills and capacity across Australian supply chains.

DMTC, through its industry and research partners, has demonstrated capabilities in naval shipbuilding and associated technologies and is well placed to provide significant expertise to a reinvigorated Australian naval and maritime sector, including both surface ship and submarine programs.

In 2017-18, projects within DMTC's Maritime Program achieved a number of significant technology developments, ranging from technical breakthroughs in material development to on-board trials of prototype products and the creation of sovereign industrial capability in critical areas.

MARITIME PROGRAM
Highlights

GROWING YOUR OWN

DMTC's work on single-crystal piezoelectric ceramics is directly relevant and of strong interest to Australia's aspirations for its submarine and surface ship fleets into the coming decades. In this regard, it encompasses aspects relevant to the Future Frigates' anti-submarine warfare (ASW) capability as well as the SEA 1000 Future Submarine Program and continuing mid-life upgrades and sustainment requirements of the Collins submarine fleet.

The work in conjunction with industry partner Thales Australia and research partners ANSTO, UOW and UNSW is making significant in-roads, with the technology providing increasingly new results which bring it much closer to being ready for in-country commercial production. This will help guarantee access to a supply of quality crystal piezoelectric ceramics, and provide Australian industry with a world-leading capability to design and fabricate sonar transducers for the Royal Australian Navy (RAN).

Local development in Australia of single crystal piezoelectric ceramics is currently limited by issues with the supply of single crystals from overseas. In response to increasing demand and need for sovereign supply certainty, the project is developing the technology solutions to enable establishment of a manufacturing capability in Australia.

A range of technical challenges including optimising powder compositions, surface chemistry and chemical processing have been overcome, allowing for the promotion of solid state crystal growth that, in turn, is required for advanced transducer devices.

Increased single crystal growth size and performance is now closely matching that achieved by overseas suppliers, achieved by overseas suppliers, with the added potential for significant manufacturing cost savings. Continuing research is focused on fully characterising the properties that will enable the technology to be considered for commercial scale production. A new ceramic powder leaching method has also significantly simplified the manufacturing process.

The significant gains made by the team in 2017-18 has reduced the technical risk profile of the project and paved the way for a new set of research goals to be set for a further two years of project activity.

A WINDOW TO THE FUTURE

DMTC's strategic partnership with Naval Group Australia (formerly DCNS) was announced in early 2017. While Naval Group's footprint in Australia is expected to be dominated by its selection as the builder of the Future Submarines, the early engagement with DMTC has focused on sharing and building knowledge of advanced surface shipbuilding techniques.

The first DMTC project to involve Naval Group as the industrial partner was a scoping study that also included DST, UoW and ANSTO. The project investigated the feasibility of new, low distortion joining techniques and applications. An early candidate for this work has been T-joint stiffeners that are widely used in naval shipbuilding but are difficult to weld. Weld distortion can impact on assembly in the shipyard due to breaches of fabrication tolerances, issues associated with residual stress and ultimately to the vessel's rigidity.

The project team is employing a range of non-destructive testing and finite element modelling techniques, to compare the results of welding trials using both traditional gas metal arc welding (GMAW) and the Tandem GMAW (T-GMAW) method. The models are also being used to predict the weld distortion on larger ship assemblies, with the ultimate aim to eliminate distortion during production. The T-GMAW process has been developed and refined by DMTC project teams over a number of years and, having been deployed on different land and maritime platforms, has already proven to be applicable beyond shipbuilding and across defence industrial domains.

The results of this scoping study have been very positive and are of significant interest to Naval Group, with follow-on research projects under development.

PERSISTENCE PAYS OFF

Under contract with the Defence SEA 5000 program, DMTC has led collaborative technology development efforts to achieve advances in thermal spray technologies.

DMTC worked with industry partners MacTaggart Scott Australia and United Surface Technologies and research partners Swinburne University of Technology (SUT) and DST to develop and characterise high velocity oxygen fuel (HVOF) coatings for marine applications.

The project has demonstrated that HVOF can be used to apply single layer carbide based coatings to naval hydraulic components, and that these coatings offer improved performance and cost reductions over current coating solutions.

The benefits of this innovation include the option to repair – rather than needing to remove and replace – key marine hydraulic structures on naval platforms that are susceptible to corrosion. This promises significant benefits to Defence including reductions in through-life (sustainment) costs and improved in-service availability of platforms. The project has also shown that these coatings can be applied to new components to enhance their biofouling performance and corrosion resistance.

More than 100 samples have undergone more than 1,500 hours of in-water field testing, along with impact testing and hot-water immersion test activities, demonstrating that the new coating formula significantly out-performs existing solutions.

The project's trajectory towards TRL7-8 has recently achieved a significant boost with the RAN agreeing to trial the technology on-board HMAS *Canberra*, one of two new landing helicopter dock ships (LHDs). This involves replacing stanchion piston rod coatings with the current project's HVOF and Air Plasma Spray coatings to enhance corrosion protection and prevent surface degradation. This on-ship trial is being conducted over a period of eight to 12 months.

Consistent with the DMTC's aims in building sovereign Australian industrial capability, the project has also developed industrial capability across an in-country supply chain of SMEs.

Assoc Prof Geoffrey Will, QUT, (centre) and Dr Steven Knight, SUT (right) show Marine Technician CPO Todd Newman (left), how the corrosion prognostic monitoring system works during the systems installation in the Gas Turbine Machinery Room onboard HMAS *Parramatta*, Sydney.

LAND

Dr Bahman Shabani, Senior Lecturer at RMIT Bundoora checks the hydrogen fuel cell, which has a maximum capacity of 5kW. The electronic load bank draws power from the fuel cell to demonstrate the load and can be varied to simulate different uses of the power by auxiliary functions.

The Australian Army needs to not just be ready to fight, but to equip its soldiers to survive, fight and win.

DMTC is a valued partner in enhancing Defence capabilities through technology enhancements, underpinning supply chain improvements and broader industrial capability outcomes. In all of these activities the Defence customer and the needs of the warfighter are kept at the centre of considerations.

With an internationally competitive Australian defence industry now recognised as a fundamental input to defence capability, DMTC's work assists Australian defence industry to ensure its work is both world-class and cutting-edge.

In supporting the development of better, robust and smarter material to go into defence platforms, DMTC's project teams have consistently proven, over the decade, to be an effective enabler and a trusted contributor to the technologies, capabilities and platforms that the Army needs.

DMTC's Land Program focuses on improving materials used in land-based military systems by reducing weight to increase payload and mobility for soldiers and vehicles alike.

Researchers are developing power technologies and novel blast survivability concepts, and benchmarking these against existing vehicle systems to demonstrate the performance advantages. Research into functionally integrated soldier systems for the networked battlefield of the future is underway building on a decade of DMTC activity in body armour, helmets, textiles and power systems.

Innovative approaches that provide productivity enhancements in manufacturing or that reduce the cost of ownership by optimising maintenance practices are also high on the Army's agenda.

DMTC is working with industry to apply and extend research and development to deliver solutions in these areas identified as priorities by Defence for the land force of today and the future force.

LAND PROGRAM
Highlights

POWER FOR DEPLOYED FORCE ELEMENTS

A DMTC project team has developed a fuel cell auxiliary power unit (APU) concept demonstrator (using commercially available, off-the-shelf components) that has the potential to replace or augment noisy diesel generators on armoured vehicles.

The benefits of hydrogen fuel cells include the ability to run quietly for longer (to enable use on operations in silent watch mode), their very low heat signature and no emissions aside from water vapour.

Compared with the diesel generators that they could potentially replace, hydrogen fuel cells require very little servicing and repair due to the lack of moving components. This has a direct impact on lifecycle costs and maintenance planning.

While the infrastructure to support hydrogen storage and use is not as well-established as for conventional fuels, hydrogen has the benefit of being able to be generated and stored on military bases as required, via electrolysis.

The techno-economic study underpinning the DMTC team's technical activities found that this alternative offers environmental benefits and the potential for long-term cost benefit over purchasing, transporting and storing diesel fuel.

The system demonstrator was developed over three years by a DMTC team involving industry partner Thales Australia and RMIT.

The system uses a hybrid hydrogen storage method by utilising metal hydrides and high-pressure tanks designed to fit inside one of the standard locker spaces typically found on armoured vehicles. The metal hydrides allow the storage of hydrogen at low pressure which reduces the associated risks of carrying and handling high-pressure tanks on a military vehicle in the field.

The fuel cell system has been successfully 'bench-tested' to operate as an APU within an armoured vehicle locker. The scheduling of a trial involving a fielded Bushmaster protected mobility vehicle is yet to be confirmed.

There is significant potential for the project activity to be extended to maximise the benefits for vehicle manufacturers and, ultimately, to inform the design of future generations of specialist military vehicles for Defence.

BETTER PROTECTION IN THE FIELD

Ground-breaking nanofibre technology is being applied to develop next-generation protective suits to safeguard Australia's defence force personnel against chemical attacks.

Funded through the Defence Innovation Hub, the DMTC team comprises research partners CSIRO, DST and RMIT and industry partners Bruck Textiles and Revolution Fibres.

The team's efforts build on years of research that were initially funded through predecessor innovation programs in Defence.

Existing suits that safeguard military personnel against chemical agents are largely based on yesterday's technology. The suits are designed specifically for operating in hazardous environments for short periods, rather than being suitable for use over long periods or in a range of operational conditions.

The objective of the nanostructured fabric project is to provide better protection against aerosol and vapour threats with minimal extra weight or heat burden, allowing deployed forces to operate for longer periods in hazardous environments.

The most significant impact of the technology is that the nanofibres used weigh almost nothing but filter out dangerous chemical vapours as effectively as the existing material solutions that are far heavier.

Nanofibres are generally polymer fibres with diameters at least 100 times thinner than a human hair. The benefits of nanofibre technology are seen in everything from human tissue engineering and wound healing to drug delivery, battery systems and optical sensors.

The textile structure protects the wearer from airborne hazards travelling into the fabric while maximising comfort by remaining fully breathable, allowing heat to travel out of the fabric.

Four separate layers are fused together in a specialised configuration that does not compromise the nanofibre layer's porous quality and allows the finished fabric to breathe while still filtering particles and gases (as illustrated below).

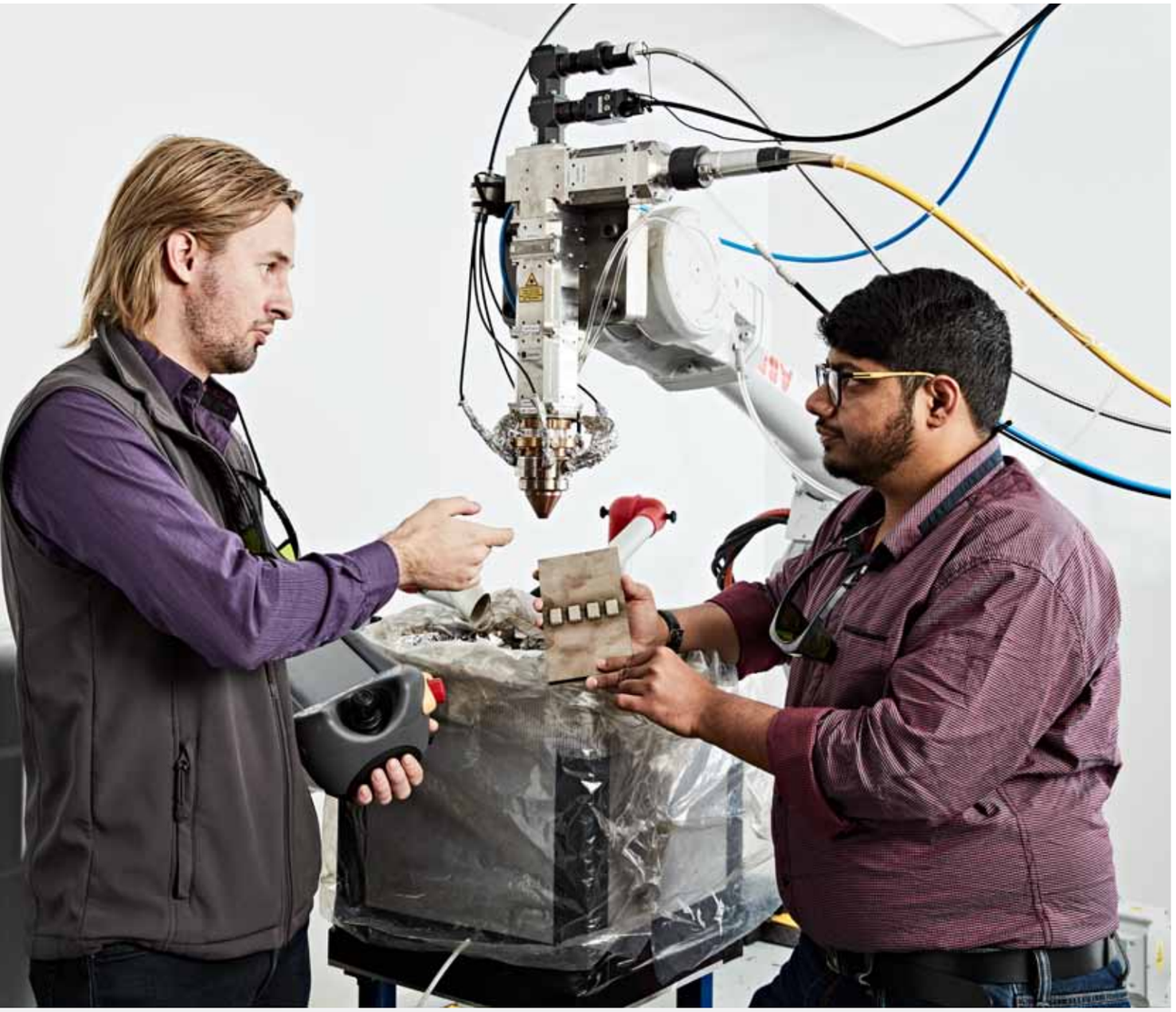
Exhaustive testing has shown the new fabric to be highly effective at removing toxic chemical vapours and able to efficiently filter particles. To confirm its durability, the material also passed extensive flex testing with flying colours.

This Innovation Hub project is developing new technology to protect ADF personnel against a range of chemical, biological and radiological threats. Next steps envisaged for this technology include continuing to improve thermal comfort levels and progressing to prototype garment production and supply chain development.

The outcomes of this project are also expected to have applications outside Defence including for emergency workers responding to chemical spills or other toxic hazards.

Lightweight, breathable CBR suits are now possible because the multilayer, composite construction combines multiple functions (breathability, aerosol protection and chemical protection) into a single fabric.

AIR



RUAG Australia Advanced Technology & Engineering Solutions (ATES) Engineer, Mr Nicholas Orchowski (left), and SUT Research Engineer Dr Rizwan Rashid (right). The 300M ultra-high-strength steel deposits (held by Dr Rashid) are used for validation and verification testing for structural restoration for aerospace applications.

Over the past decade DMTC has, through its Air Program, sought to address a range of key challenges facing the Australian defence industry in the manufacture and sustainment of aircraft components and systems.

In this way, DMTC and its partners are enabling the Royal Australian Air Force (RAAF) to optimise the management of its in-service fleets while also preparing to capitalise fully on the high technology systems being acquired to deliver air superiority into the future.

Our work is a reflection of what the RAAF is doing with its Plan Jericho initiatives – ensuring that innovation is matched with discipline and focus. Our program efforts are also closely monitored to ensure alignment with DST's technical objectives and with Defence's overarching airworthiness requirements.

Successive DMTC projects in the Air Program have delivered technological breakthroughs, and developed and embedded new technologies and capabilities into supply chains. Over the decade, the pendulum has swung from a concentration of activity around advances in machining, to our current work on advanced manufacturing technologies and techniques.

Working with new manufacturing techniques and new materials involves a progression through identifying, understanding, enhancing and then certifying them to meet the demand of our Defence customer for high integrity, high value and high performing components.

DMTC's work is focused on building the underlying capacity and competitiveness of Australia's national industrial base, supported by research expertise and knowledge.

AIR PROGRAM
Highlights

BUILDING ON SUCCESS

A long-time DMTC collaboration involving industry partner RUAG Australia and research partners DST, SUT and RMIT has, since 2009, focused on developing and enhancing surface treatment and repair technologies, namely laser cladding technology (LCT) and supersonic particle deposition (SPD).

LCT is one of a raft of emerging manufacturing technologies that use powder to repair machine components suffering from wear and tear. When fused to the substrate surface, the layer-by-layer build-up yields high quality depositions with high bond strength (see image page 14).

SPD deposits powder to the substrate by ejecting it from a nozzle at high speed. While SPD is currently available to the market, the DMTC project work has improved nozzle design for greater ejection speed and also worked to develop a field-deployable solution.

The successful completion of a series of related technical milestones in 2017-18 has led to a new project agreement to characterise the laser cladding process and specifically its application to ultra-high strength steels, titanium alloys and nickel alloys.

Detailed work is now underway to take the structural restoration technology through an exhaustive validation and verification testing program prior to its certification and transfer of the technology to industry for commercialisation.

The team is also continuing to produce more technologically integrated cladding systems in order to rebuild the damaged surface area in a more controlled manner.

For the industrial base, technological advances in these areas can introduce new skills and deliver significant productivity gains. For the Defence customer these advances can reduce the demand for replacement parts that are typically expensive, difficult to source and present a key risk to effective maintenance scheduling.

The establishment of a state-of-the-art sustainment and repair facility at RUAG Australia in Melbourne promises to be an important in-country capability, and would signal a significant return on many years of investment and effort from DMTC, DST and the industry and research partners.

> “Industry owns the creation of the information and technological edge that we seek, not Air Force. Air Force owns its realisation. Collaboration with industry is a surer way to develop the next big disrupters and to counter disruptive threats.”
>
> **Deputy Chief of Air Force, AVM Gavin Turnbull AM**

ENHANCING CORROSION PROTECTION

Aircraft platforms are often required to remain in service for three or four decades, and this puts a premium on the work of DMTC and its partners to counter a range of causes of damage and deterioration including corrosion, structural fatigue and foreign object damage.

A particular challenge related to the ADF’s in-service helicopter fleets is the utilisation of magnesium alloys in the production of gearboxes and associated housings. While there are some advantages in terms of tensile strength, density and vibration damping performance, poor corrosion resistance is a significant limitation on the use of magnesium alloys in defence equipment platforms.

Corrosion, when discovered, can be sufficiently severe to render components as ‘beyond economic repair’, and replacing gearbox components requires extensive offline maintenance work and disassembly of the entire gearbox structure. As such, any improvements that can be made to the corrosion resistance of the component – in terms of enhancing its material structure – will translate into extension of service life and reductions in the maintenance cost and burden to Defence. More recently developed magnesium alloys are reportedly more corrosion-resistant but are not yet widely utilised.

To address these challenges, the DMTC collaboration involving DST and UQ is developing a deeper understanding of the corrosion behaviour of legacy and emerging magnesium alloys. Importantly the DMTC project is also evaluating the performance of existing and developing improved coatings for application as protective barriers on these magnesium components. The project is seeking to remediate a range of corrosion-related issues not covered by other DMTC maritime or air platform projects.

The project will involve detailed testing, including field trials, of the potential suitability and effectiveness of a range of corrosion-inhibiting treatments and schemes. The expected outcome is a significantly-improved scientific understanding which will enable designers, manufacturers and maintainers alike to modify their practices in order to achieve improved corrosion performance.

Legacy magnesium alloys including the ZE41A-T5 compound used on gearbox housing components are noted for their strength and hardness but suffer from poor corrosion resistance.

ENABLING TECHNOLOGIES
Overview

A strong focus of DMTC's work for our Defence customer over the decade has been to enhance platform-independent technologies and underpinning supply chains.

DMTC's Enabling Technologies Program provides scientific and technological expertise in areas where a technology has the potential to be applied across one or more of the land, maritime, air and space domains of defence activity.

The work done by DMTC and its industry and research partners is at the leading edge of research and advanced materials development, and opens up opportunities across a broad spectrum of applications and potential commercialisation pathways.

This is extremely challenging but also vitally important work. The combination of research expertise and industrial pedigree is delivering results that promise dramatic decreases in manufacturing time and cost while maintaining or enhancing quality and functionality.

One example is our work on hybrid composite materials for defence applications, that is focused on identifying compounds that are lighter in weight or more durable and versatile while offering comparable or enhanced levels of strength, toughness and functionality. While the current focus is on land vehicle applications, the knowledge gained from this work – and the robust evaluation and characterisation processes being applied or developed to underpin the selection of candidate materials – is expected to be applicable across the defence domains.

Realising the potential to apply innovations across traditional industrial boundaries is vitally important to extracting the best value from investments made in research and development activities, and to achieving a genuine capability edge for Defence.

Pictured: The 'internet of things' in action at Sutton Tools. For SMEs in particular, Industry 4.0 can be about digitisation and integration of legacy factory equipment and not necessarily a high-cost fitout with new autonomous machinery.

ENABLING TECHNOLOGIES
Highlights

NEW MATERIAL COMPOUNDS FOR EXISTING COMPONENTS

DMTC is leading studies into the potential use of hybrid composites – that is, new compounds that combine the advantages of multiple material systems to create components that outperform traditional metals or other manufacturing materials.

Lightweighting is a priority for militaries worldwide, to ensure forces are protected, deployable and agile. DMTC and its partners are looking to uncover novel material compounds that offer comparable or enhanced levels of survivability and performance without increasing the load or weight burden on either the dismounted soldier or the land vehicle platform.

DMTC's work on alternate material solutions is providing vital performance data, simulation, damage and life-of-type analysis that can be fed into the engineering and design of future vehicle components.

The involvement of both researchers and industry partners allows the team to test new material configurations and identify the differences in performance as compared to conventional materials.

All technical milestones have been achieved under the first of three planned stages of this multi-year project. DMTC is working with Thales Australia, Imagine Intelligent Materials, UQ, Deakin University, SUT and RMIT. In 2018, Tasmanian SME Penguin Composites joined the project team.

Consistent with DMTC's dual aims to enhance Defence capability and build Australian industrial capability, our project team is seeking to both:

- evaluate the suitability of specific hybrid composite structures, including complex sandwich structures and the use of nanomaterials to provide added strength and functionality, for potential application on Defence platforms
- exploit opportunities to develop and upskill domestic supply chains to produce and integrate selected hybrid composite material systems into defence manufacturing.

To provide the technical assurance that the Defence customer demands, the investigation of new or unique composites will necessarily involve comprehensive testing against a complex set of scenarios including threat survivability, mobility, functionality and durability in a variety of terrains, and extreme thermal environments.

As with many DMTC projects, proving the cost-effectiveness of new materials is also extremely challenging due to the low volume of parts typically required for military vehicle production runs, and the relative immaturity of supply chains given the novel characteristics of the new material structures.

EMBRACING ADVANCED MANUFACTURING

DMTC's 'Factory in a Box' project involves Sutton Tools as the industry partner, with RMIT, UQ and the Advanced Manufacturing Growth Centre. The project seeks to realise benefits of Industry 4.0 adoption for Australian SMEs and, in turn, to build their credibility and prospects of engaging in defence sector supply chains.

Many commercial offerings related to the adoption of Industry 4.0 and Internet of Things technologies focus on the installation of customised, large-scale manufacturing equipment.

By contrast, DMTC's approach will assist Australian defence SMEs to take vital early steps on the digital transition journey. The concept is to offer a low-cost entry point for SMEs, helping them to understand the commercial return associated with Industry 4.0 investments before moving forward.

A key element of DMTC's solution is the ability to retrofit the Factory in a Box package of technology to legacy equipment within an SME's manufacturing facilities, overcoming perceptions that digitalisation is a high-cost or green-field activity.

Use of smart sensors and other digital tools to create a real-time view of a company's end-to-end processes (sometime referred to as a digital twin) helps to ensure that management decisions are based on hard data, and is a critical step towards full-scale realisation of the benefits of Industry 4.0.

Significant progress has already been made, with manufacturing and testing of several elements of a demonstrator system and the investigation of additive manufacturing techniques to expedite production schedules.

The project is also addressing organisational culture issues by taking a 'shopfloor' approach to Industry 4.0, ensuring the whole of the business is engaged on the journey.

The deployment of the Factory in a Box will assist SMEs to develop a company-wide Digital Strategy and will be supported by a comprehensive training package.

DMTC's involvement ensures that specific needs of defence manufacturers are prioritised and that there is a strong focus on technology transfer and supply chain development.

Future phases of the project are already envisaged, including the possible deployment of Factory in a Box training through DMTC's Industry Capability Development program.

> "Embracing the digital transformation of manufacturing and Industry 4.0 is becoming crucial to our nation's competitive advantage. The stakes could not be higher. Every Australian manufacturer has the opportunity to advance, and a viable pathway is taking practical actions to adopt Industry 4.0."
>
> **Dr Jens Goennemann**
> **Managing Director AMGC Ltd**

ARRL Medical Scientist, Ms Chelsea Nguyen, runs a sample on the FilmArray Warrior Panel to specifically test for Coxiella burnetii, the pathogenic agent causing Q Fever. Q Fever is a severe, flu-like illness and is endemic in Northern Australia. Coxiella burnetii not only has the potential to infect military personnel but could potentially be manipulated for use as a biowarfare agent. The work being undertaken by ARRL and DST under this DMTC-led project capitalises on ARRL's experience and expertise in dealing with Q Fever and represents Australia's contribution to an international program to test and evaluate the accuracy of the FilmArray diagnostic. The Warrior Panel can identify up to 16 biowarfare pathogens in a single fluid sample and has been developed with specific application to military and national security contexts in mind, rather than broader clinical applications.

MEDICAL COUNTERMEASURES
Overview

The DMTC Medical Countermeasures (MCM) Program has made significant progress in developing a sovereign Australian capability which addresses the defence and national security requirement to protect ADF personnel against Chemical, Biological and Radiological (CBR) threats, emerging infectious diseases and pandemics.

DMTC's MCM Program is positioning Australia to become a regional leader by harnessing expertise and resources from across civil and military domains. Across three rounds of proposals to date, more than 170 unique industry and research partner organisations have contributed to submissions.

DMTC has leveraged financial contributions from CSIRO and Defence's Next Generation Technologies Fund, managed by DST, to undertake collaborative technology development projects that protect, diagnose or treat CBR threats to which personnel deployed in Australia and overseas may be exposed.

Commander Joint Health and Surgeon General of the Australian Defence Force (SGADF), along with the Chief Defence Scientist, represent the Defence customer on the MCM Stakeholder Group. This Group drives the priorities for the Program and includes leaders from CSIRO and from the Departments of Health, Industry and Foreign Affairs & Trade.

The MCM Program aims to develop an advanced development and manufacturing supply chain that reduces Australia's historic reliance on imported products. This is significant in the context of two future scenarios: a global event which may result in closed international borders; or a specific threat in our region for which there may not be readily available solution on the international market.

MEDICAL COUNTERMEASURES Highlights

DIAGNOSIS AT THE POINT OF CARE

DMTC has worked collaboratively with lead industry partner Lumos Diagnostics (a wholly owned subsidiary of Planet Innovation) with support from Anteo Technologies and research partner Deakin University. The aim of the project to adapt an existing test cartridge to enable rapid testing and identification of a panel of defence-relevant infectious disease agents.

There is a clear military and civilian need for high sensitivity point-of-care (POC) testing as existing products offer limited performance and deployability. The DMTC team's response to this requirement has demonstrated innovation and achieved significant technical breakthroughs.

The reader device has been specifically designed for use in the field – in any environment where ADF personnel are deployed. This has included ensuring sufficient battery power, small handheld form factor and wireless connectivity to enable real-time transmission of results to a command outpost.

Development activities to date have achieved increases in test sensitivity and specificity through novel chemistry modifications, and optimised design of both the thread used for testing and the test cartridge itself. To date the project has delivered a fully integrated diagnostic system with improved sensitivity, specificity and performance costs over current assay systems.

The project has also developed industrial capability across in-country SME supply chains to perform tasks that have historically been performed overseas.

The DMTC team has demonstrated that the device known as Nplex can be used to rapidly identify defence relevant target pathogens, and meets the requirements of a mobile, high-precision diagnostic test which will enable the rapid detection and differentiation of multiple infectious diseases in the field.

Each assay cartridge provides the ability to screen for multiple infectious agents using a single low volume sample on one cartridge. Moving traditional laboratory-based tests onto the highly sensitive Nplex device will provide doctors and medics with valuable information to quickly assess, diagnose and treat patients without the need for specialist equipment.

The novel thread membrane used instead of existing paper-based nitrocellulose materials reduces variability of results and improves performance. In optimising the thread membrane and its production quality, the DMTC team has moved from an original cotton to an extruded polymer thread design. This work was conducted in collaboration with Deakin University and has progressed to feasibility level of development. Innovations applied to the polymer thread fibre have involved research into variables including fibre diameter, number of fibres, cross sectional shape of fibres and fibre configuration. An additional benefit of extruded thread is that it can be produced in very large quantities at low cost, making it highly suitable for high volume device manufacturing.

The project team was awarded the National Innovation Award in the Combat Equipment and Mobility category at the Land Forces 2018 conference and exposition.

TAKING UP THE FIGHT AGAINST BIO-WARFARE PATHOGENS

Bio-warfare agents can cause potentially lethal infections and many species are becoming increasingly resistant to available antibiotic treatments.

DMTC's collaboration with research partners at the University of Western Australia, DST, the Peter Doherty Institute and the University of Wurzburg is focused on delivering novel therapeutics that directly target the macrophage infectivity potentiator (Mip) protein.

Mip proteins are found in a wide range of bacterial pathogens, and are known to be important to the survival of bacteria within host cells. Mips are responsible for protein folding and by inhibiting their activity, the ability for the bacteria to grow is severely limited. By directly targeting these proteins, slower growing bacteria provides the opportunity for the host immune system to fight the bacteria without causing antimicrobial resistance.

Potential bio-warfare agents include Burkholderia pseudomallei, which causes melioidosis, and Coxiella burnetii which causes Q fever, are both endemic in northern Australia and the tropical regions to Australia's north. They are of significant interest to Defence as Australian and international troops are often deployed in these regions and personnel can be severely affected by the diseases which they cause.

The project team's initial work has successfully demonstrated the novel compounds successfully inhibit the Mip protein from the B.pseudomallei pathogen and they are now working to see if the same compounds have activity against Coxiella burnetii and Neisseria meningitidis, the bacterial causative agent of invasive meningococcal disease (IMD).

The successes achieved by the team to date, while significant, are just one step on the journey from the laboratory to a fielded solution. Next steps for this three-year project include optimising the performance of the inhibitors, with the aim of progressing to pre-clinical trials.

LOOKING AHEAD

In February 2018 a call for expressions of interest to participate in a third round of the MCM Program was issued by DMTC. This represented the next phase in DMTC's ongoing effort to realise significant financial leverage and harness and grow the expertise of Australia's MCM community.

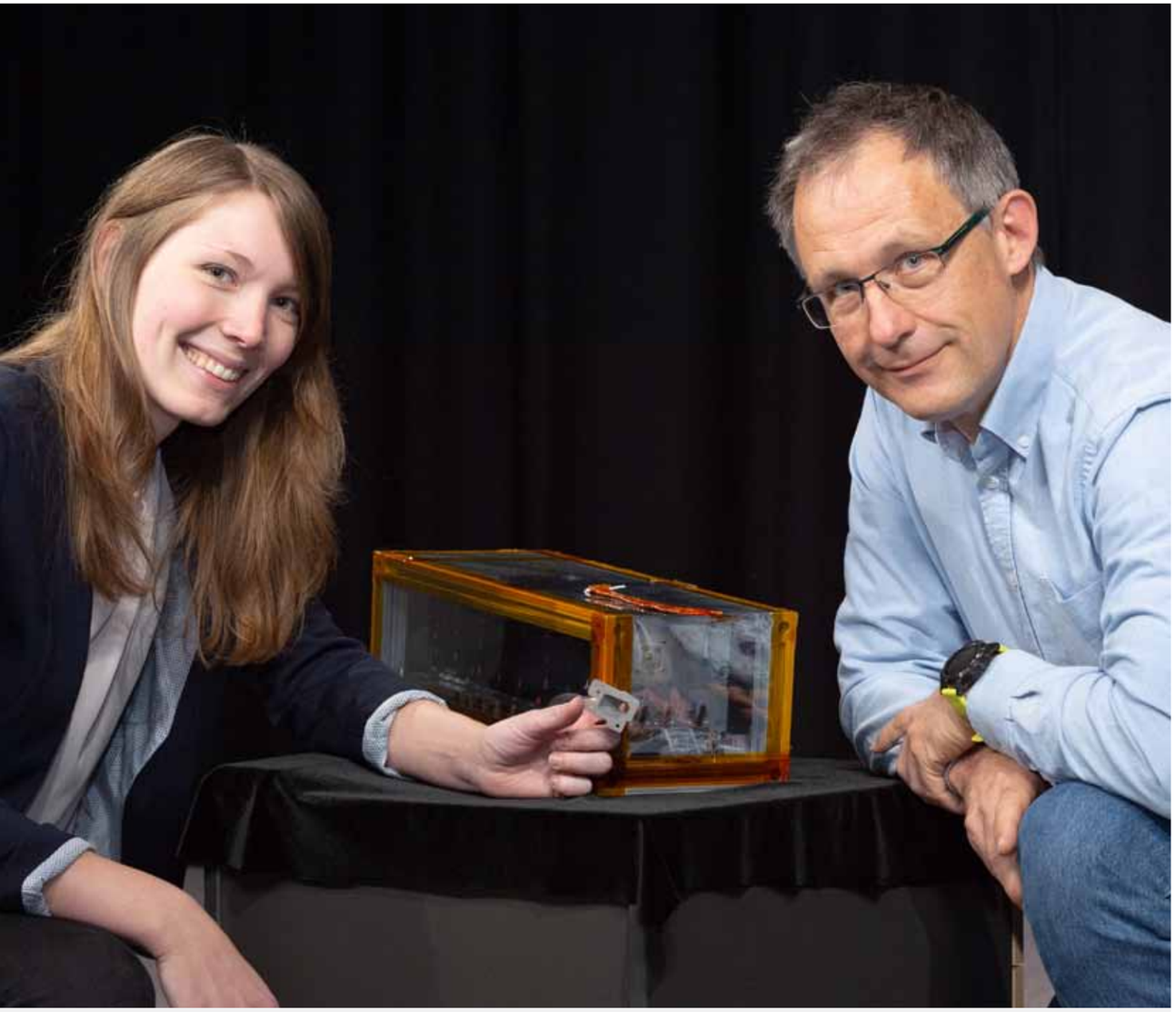
From a strong field of applicants seven were shortlisted to submit more detailed proposals. From these proposals, four projects were selected to advance to contract negotiations. It is expected that contracts will be finalised and work will commence in December 2018 or early calendar year 2019. This is in line with the annual program of the MCM Program which is explained in more detail here: *https://dmtc.com.au/wp-content/uploads/2018/07/MCM-DMTC-Prog-Development-Cycle.pdf*

The projects selected in Round 3 have a particular focus on:

- continuing to align with the priorities of the ADF, as articulated by Joint Health Command
- supporting development of in-country manufacturing capability for selected therapeutics
- building industry and health service capacity to target tropical health challenges for the direct benefit of military and civilian populations in northern Australia.

In all, including scoping studies of a shorter duration and Round 2 projects that were delayed in getting underway, the MCM Program will grow from five projects under management as at June 2018 to 11 projects under management during 2018-19.

HASS



L to R: PhD Candidate Ms Lena Sentker and Dr Doug Griffin, both of UNSW Canberra, are working on advanced manufacturing of CubeSat components, along with project partners A.W. Bell, La Trobe University and CSIRO.

HIGH ALTITUDE SENSOR SYSTEMS Program

Australia's push to refresh and broaden the capabilities of its fledgling space industry requires policy leadership from Government, expert contributions from the research sector and a greater industrial footprint, with a particular focus on Australian SMEs and start-up companies.

DMTC's High Altitude Sensor Systems (HASS) Program seeks to make a significant contribution to the growth of the Australian space industry and to the development of sovereign space capabilities for Australia.

The HASS Program was established in 2017 with seed funding provided by CSIRO, and its first projects commenced in 2018. With its focus firmly on developments in the Australian defence and national security context, the HASS Program is taking shape and is already achieving technical milestones. Detailed advice and direction is being given by a range of Defence stakeholders including DST, RAAF and the Australian Geospatial-Intelligence Organisation.

DMTC's efforts focus on:

- the miniaturisation of sensor components to optimise payload capacity
- enhancing the on-board processing of sensor data to maximise the provision of decision-ready data in near-real-time
- the application of additive manufacturing techniques and the selection of alloy materials to optimise the functionality of micro-, nano- and cube-satellites, and to achieve reductions in time taken to manufacture components.

Three projects publicly announced under Round One of the HASS Program commenced in the 2017-18 reporting year, and a further three projects linked to HASS – two existing DMTC projects and one scoping study – are also now underway. Each project team includes partners from both the research sector and Australian industry.

While the outcomes of these projects are specifically targeted to meeting Defence objectives, dual-use applications and benefits are also anticipated.

DMTC will continue to seek opportunities to expand the scope and benefit of the Program by attracting additional investment from Defence and other sources, and also by adding new partners with unique expertise as the Program matures.

HIGH ALTITUDE SENSOR SYSTEMS
Highlights

ADVANCES IN REMOTE SENSING

This project will advance passive radar capabilities with an initial focus on maritime applications such as monitoring and estimating sea-state conditions. It aims to develop miniaturised, high frequency sensor systems that will enable real-time processing of line-of-sight and reflected GPS signals from a networked constellation of CubeSats or other unmanned aerial platforms.

The technologies to be advanced under this project will directly address limitations in the current system for sea-state monitoring, particularly with regard to refresh rates and spatial coverage.

The deployment of unmanned aerial vehicles to more accurately estimate sea-state conditions – namely wave height, wind speeds and wave/wind direction – will inform better decision-making and deliver a range of benefits to Defence including improved safety, speed and fuel consumption for Naval vessels.

If proven, the capability is expected to attract strong interest including both broader Defence utilisation and commercial applications.

Early work on the project has focused substantially on design of sensor receivers making use of field programmable gate array (FPGA) technology, and validating the system's capacity for data collection, streaming and archiving.

The manufacturing of a prototype and software development to prepare for ground-based testing is expected to be complete in the first quarter of 2019.

The project is led by industry partner Seaskip with support from UNSW Sydney's Australian Centre for Space Engineering Research (ACSER), both of whom are new partners of DMTC, and builds on an extensive body of fundamental research already undertaken by ACSER. While not formally linked to the project, significant input and support is being received from DST, Navy and Air Force as well as New Zealand SME General Dynamics.

GROWING AUSTRALIA'S SPACE CAPACITY AND CAPABILITY

COMPACT, SPATIALLY AGILE SENSORS

This project is pursuing significant improvements in the military utility of compact hyperspectral imaging sensors.

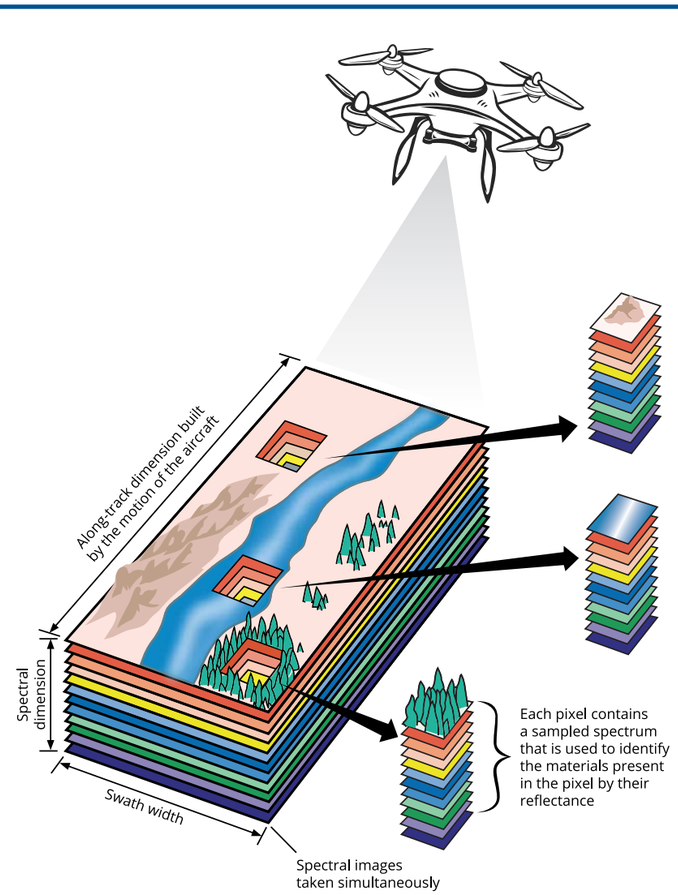
The types of compact hyperspectral sensors being developed and tested could potentially be deployed on either miniaturised satellites or one of the ADF's current or future fleets of unmanned aerial vehicles.

Current systems and fielded technologies do not yet sufficiently meet a number of key requirements of the ADF. The most critical relate to the ability for off-nadir observation, enabling a broader and angular view of the terrain rather than being limited to direct lines of sight below the airborne platform. The capacity for real-time image and information processing is another important enhancement being pursued in this project, as is reducing the weight and size of the sensors to allow them to be deployed on a small platform.

The project includes both hardware and software development. The initial phase of the project is focusing on preparatory work in the development and testing of advanced prototype systems and data processing algorithms, exploiting artificial intelligence and deep learning frameworks. This is expected to progress the technology to TRL 5.

The project involves Australian SME HyVista in collaboration with the University of Technology Sydney, both of whom are new partners of DMTC, together with DST.

Researchers on the hyperspectral sensor system project team are developing a compact imaging system with the capacity for off-nadir observation and near-real-time image and information processing.



INDUSTRY CAPABILITY
Development

> DMTC's support in setting up the titanium machining capability for the Joint Strike Fighter Program has resulted in opportunities being realised and significant exports for Australian industry, not just for BAE Systems."
>
> **Mr Brad Yelland**
> **BAE Systems Australia – Director, Engineering & Technology**

> This type of activity will be very useful in pulling together a network of capable SMEs across the country and providing them with a credible pathway to bid for work with prime defence industry contractors. And it's based on verified and benchmarked data."
>
> **Dr Mark Hodge**
> **CEO, DMTC Ltd**

> It's always a challenge to benchmark your business from one sector to another. By demonstrating that we can meet Defence's requirements, it positions our company for both current work and other opportunities in the future."
>
> **Mr Dave Hackett**
> **Managing Director, DGH Engineering (Queensland SME)**

PROGRAM CONTEXT

DMTC's involvement in a range of past and present industry capability development activities has been pivotal in building national supply chains, resulting in global opportunities for Australian industry.

DMTC's Industry Capability Development (ICD) program aims to create a national network of 'Defence-ready' companies with benchmarked, globally competitive capabilities. It is a natural fit with DMTC's strong focus on engaging SMEs in our programs.

Following previous capacity-building successes in areas such as CNC machining and additive manufacturing (3D printing), current efforts focus on enhancing Australian industry's welding capabilities. DMTC's focus on activities in the pre-competitive phases of industrial capability development, together with its approach to IP rights, facilitates skill and technology transfer throughout Australian industry supply chains.

The Australian Government's commitments to a continuous shipbuilding program and to major land vehicle contracts is expected to place pressure on Defence's existing supply chains. It is highly likely that fabrication work will need to be shared across sub-contractors to meet demand. The multinational prime contractors delivering these major programs are increasingly looking beyond traditional defence supply chains to identify highly skilled regional SMEs with valuable experience in industries such as mining and natural resources.

The multi-phase DMTC ICD Program is helping companies to move up the skills curve and demonstrate their skills in defence-relevant areas through process benchmarking and technology transfer activities. It also provides mentoring and evidence-based feedback on what SMEs need to do to lift themselves up the skills curve.

The DMTC team leading the workshops involves research partners from UoW and SUT with assistance from the Centre for Defence Industry Capability (CDIC) and relevant certification partners including Weld Australia.

For the prime contractors, DMTC's benchmarking and technology transfer programs continue to:

- build the depth, quality and international competitiveness of the supply chains supporting their Australian operations
- assist with meeting commitments to maximise Australian industry content in programs
- put Australia 'on the map' in relation to decisions about work packages flowing to Australian subsidiaries of global primes.

Participants in the multi-phase program receive information and mentoring in the latest technologies currently being applied to the welding of defence platforms such as automation, offline programming and augmented reality.

INDUSTRY CAPABILITY
Development

PROGRAM DELIVERY

DMTC's multi-phase program is intentionally seeking to:

- leverage the experience and success of previous benchmarking activities, Computer Numerically-Controlled (CNC) machining and tooling, additive manufacturing
- respond to concerns regarding Australian industry's capacity and competitiveness
- align with the focus on Australian industry as a Fundamental Input to Capability and efforts to maximise Australian industry involvement in major Defence projects
- engage with areas of regional Australia with as-yet untapped potential to contribute to the defence sector.

The program continued to grow in 2017-18 with support from the Queensland Government for five regional ICD projects based on welding of high strength steels for both maritime and land vehicle applications. DMTC is working closely with Defence Industries Queensland to assist manufacturers to maximise opportunities to enter defence industry supply chains.

The projects in Mackay and Cairns focus on the welding of high-strength steels for naval and maritime platforms, while the Townsville, Rockhampton and Brisbane projects will address steels and technologies applicable to land vehicle platforms.

While involvement in DMTC's project does not equate to a formal welding accreditation or qualification, the opportunity to work with candidate materials and consumables provides a key indicator of an SME's capability and potential to qualify against the formal Australian standards. It also provides companies with an overview of available defence sector opportunities and an understanding of the levels of performance and responsiveness expected by the defence primes.

Each regional project consists of an initial detailed questionnaire to understand the capability of the participants. This allows DMTC to tailor the project to the experience of the participants. This is followed by a workshop to introduce companies to Defence, to working with DMTC and to the scope of the project.

The next stage of the project involves the preparation of the standard paperwork for the weld process followed by welding trials on a set of representative test plates. A local test house is used to provide the necessary assessment of the welds. The test results are analysed by DMTC and the results are used to facilitate follow-on mentoring and contact with experts in the DMTC team. The weld results themselves form only a part of the entire assessment with a significant focus on the timely and effective delivery of the initial paperwork through to the final information pack.

Throughout the projects, information is also shared on the latest technologies currently being applied to the welding of defence platforms such as automation, offline programming and augmented reality.

Companies engaged to date have reported positive outcomes including:

- education on the latest techniques and processes in welding high strength steels
- information on the international standards and processes required for the defence sector
- recommended pathways to welding practice improvement such as use of digital technologies for steel fabrication and installation
- opportunities to network and collaborate to establish regional capability clusters.

DMTC is also planning to expand the Program to address other specific manufacturing technologies to enhance Australian industrial capability. Some examples include additive manufacturing and casting techniques, along with technologies critical to the digitalisation of manufacturing.

BUILDING CAPABILITY
ACROSS AUSTRALIA

PROGRAM PHASES

1	Focusing on regional clusters of capability – companies with readily transferable skills to move into the defence sector (e.g. resources, automotive).
2	Setting regional clusters within a national network of capability, and engaging with the primes to embed the Defence sector context.
3	Continuing optimisation, innovation and technology insertion to supply chain partners, maintaining best practice.

ANNUAL CONFERENCE 2018

DMTC CEO Dr Mark Hodge and Senator David Fawcett present Dr Mitali Sarkar-Tyson with her Project Leadership Award.

The expansion of DMTC's research programs attracted new delegates and keynote speakers from Australia and overseas to this year's annual conference, held on 20 and 21 March in Canberra.

Australia's then Minister for Defence Industry, the Hon. Christopher Pyne MP, told delegates that DMTC continued to have a 'vital' role to play, with the prospect of more than a dozen new industry and research partner organisations joining it in the first half of 2018 alone.

In addition to the Minister, DMTC was honoured to have several keynote speakers share their insights at the conference, including:

- Mr Paul Johnson, Co-Chair of the CDIC Advisory Board
- Mr Brent Clark of Naval Group Australia
- Air Vice-Marshal Tracy Smart, Commander Joint Health and Surgeon General of the ADF
- Mr Brian Hickey of the Future Frigate Program Office in Defence's Capability Acquisition and Sustainment Group
- Dr Rob Grenfell of CSIRO's Health and Biosecurity Business Unit
- Mr Chris Hewett of the Australian Geospatial-Intelligence Organisation.

AWARDS for Excellence

The DMTC Awards for Excellence recognise significant contributions made by individuals and teams that have resulted in successful outcomes for DMTC and its partners. This year's Awards were presented by DMTC CEO Dr Mark Hodge and Senator David Fawcett at the Annual Conference Dinner at the National Gallery.

DMTC Maritime Program Leader ***Dr Stephen van Duin*** won the prestigious ***Research Collaboration Award*** for his outstanding leadership. Dr van Duin is an Associate Professor at UoW, a long-time research partner of DMTC. The Maritime Program has grown significantly due to Dr van Duin's collaborative efforts, and has made substantial contributions to Australia's industrial capability in relation to the SEA 5000 Future Frigate Program and naval shipbuilding generally.

The ***Industry Partnership Award*** was awarded to ***Steven Knight*** from SUT for his contribution to a project that is developing a corrosion monitoring and prognostics tool. The tool is undergoing on-ship trials on Navy Anzac class frigates in consultation with Defence and industry partner BAE Systems Australia.

The ***Project Leadership Award*** was presented to ***Dr Mitali Sarkar-Tyson*** for her outstanding leadership of a project involving research partners at the UWA, DST, the Peter Doherty Institute and University of Wurzburg. The project is focused on delivering novel antivirulence compounds, which are active against potential bio-warfare agents including Burkholderia pseudomallei.

DST researcher ***Vanessa Pickerd*** won the ***Early Career Award*** for her excellent contribution to a DMTC project focused on enhancing life-of-type evaluations of Navy frigates. This award is open to technical officers, engineers and scientists, including PhD students, who are working on DMTC research projects and are aged under 35.

The ***Capability Improvement Award*** went to the team at ***ANSTO and Thales Australia*** who are developing a single crystal growth process to pave the way for in-country production of sonar transducer components.

Top to bottom: The Hon. Christopher Pyne MP, the then Minister for Defence Industry; Ms Sharon Wilson, Head of Industrial Strategy, BAE Systems Australia; Mr Paul Johnson MBE, Co-chair CDIC Advisory Board; Dr Kimberley Clayfield DMTC HASS Program Leader.

HONOURING Excellence

DMTC's Board of Directors created the organisation's first Honorary Fellowship positions this year to recognise significant meritorious contributions to the goals and objectives of DMTC and its partners. The first three Fellowship recipients as announced by Chair Mr Tony Quick at the DMTC Annual Conference in March 2018 (pictured below) were:

- Emeritus Professor David St John
- Dr Peter Preston
- Emeritus Professor John Norrish.

It is particularly appropriate, in the year marking a decade since the formation of DMTC, that the Board recognised three individuals who were instrumental in the creation of DMTC and setting the path for continuing success.

Emer Prof St John's efforts were pivotal in the conception and management of the original bid for the DMTC contract in 2007, assembling industrial and research partners, most of whom are still active in the organisation today.

> ***"We're thrilled that someone of David's international reputation was and still is, so passionately involved in our organisation." – Mr Tony Quick***

Dr Preston's leadership of the fledgling organisation as Chair of the Board from 2008 to 2011 was pivotal. He set the strategic vision, guidelines and policies by which DMTC still operates today, and a strong, principles-based approach to both internal and external negotiations.

> ***"Peter Preston was in so many ways, the father of DMTC following our announcement as the successful consortium for the initial contract." – Mr Tony Quick***

With a peerless global reputation in his field of welding, Emer Prof Norrish has been tireless in his involvement in DMTC's technical programs over the past decade, and a champion and active architect of DMTC's Education Program.

> ***"We have all benefited from his unquenchable energy, vitality, willingness and ability to get involved in the detail of so many of our critical programs."***
> ***– Mr Tony Quick***

Read Emer Prof John Norrish's personal reflections on DMTC – from its inception to current day operations – on page 13.

Left: Emer Prof John Norrish, DMTC Chair Mr Tony Quick and Emer Prof David St John at the presentation of Fellowships.
Right: DMTC's current Chair commends former Chair and new fellow Dr Peter Preston (on screen).

YOUNG INNOVATOR Award

Mr Peter Kabakov was awarded a Young Innovator Scholarship by the then Minister for Defence Industry, the Hon. Christopher Pyne, at the Maritime Australia Industry Innovation Awards.

DMTC has long been dedicated to attracting Australia's brightest young minds to defence innovation, so it was with great pride that we celebrated the achievements of Mr Peter Kabakov at the Maritime Australia Industry Innovation Awards.

Mr Kabakov was awarded a Young Innovator scholarship by the then Minister for Defence Industry, the Hon. Christopher Pyne MP, on 4 October at the Pacific 2017 International Maritime Exposition in Sydney.

Local development of acoustic transducers for underwater sonar systems is limited by a current reliance on imported single crystals. Employed by ANSTO, Mr Kabakov has worked on a DMTC project with industry partner Thales Australia to establish an Australian production capability for single-crystal piezoelectric ceramics.

It encompasses aspects relevant to the Future Frigates' ASW capability as well as the SEA 1000 Future Submarine Program and continuing mid-life upgrades and sustainment requirements of the Collins submarine fleet.

The collaboration between the partners has combined the microanalysis and ceramic processing expertise at ANSTO with the piezoelectric specialists at Thales Australia. Continuing research will fully characterise the properties that will enable the single-crystal piezoelectric technology to be considered for commercial scale production.

Mr Kabakov's achievements are a great exemplar of DMTC's ambition to be an organisation of choice for Australia's best young researchers by identifying, sponsoring and providing unique opportunities for future research and industry leaders.

Peter's team comprising Thales and ANSTO representatives was also successful in winning the Capability Improvement Award at DMTC's Annual Conference (see page 49).

EDUCATION PROGRAM
Overview

DMTC's Education Program has a long-standing commitment to supporting Australia's next generation of Defence scientists and engineers. Over the past decade, it has assisted 48 PhD and Masters candidates with scholarships, operational funding, travel and conference support. DMTC also has a vacation student program, placing 3rd and 4th year engineering students from partner universities on industrial targeted 12-week projects.

PhD and Masters scholarships are awarded based on alignment with future Defence capability requirements and industrial opportunities for Australian industry. This approach ensures the best and brightest can make meaningful contributions to Defence capability throughout both their studies and their careers.

DMTC has a successful track record of transitioning postgraduates into careers in the Defence sector, whether with research or defence industry organisations or with Defence itself.

DMTC also plays an important role in bringing together a cohort of Defence-focused PhD candidates across a range of disciplines. The DMTC Education Program incorporates PhD and Masters candidates from The Research Training Centre for Naval Design and Manufacturing and the Defence Science Institute. This is a great opportunity for students and supervisors from various technical disciplines to network and collaborate on areas of common interest. Engagement with aligned Research Training Centres and other State-based innovation networks is a model DMTC is looking to replicate and extend in the future.

DMTC holds an Annual Student Conference as well as professional development workshops each year that allow students to hone their presentation, writing and other skills that align with the needs of Defence, industry and research partners, enhancing career prospects and opportunities for students in the defence sector.

PHD & MASTERS
Candidates

MR BRODIE MCDONALD

Mr Brodie McDonald is a PhD student at RMIT's School of Engineering, where he also completed his undergraduate degree in aerospace engineering in 2014. The focus of his PhD project, titled 'Characterising Material Effects in Blast Protection' was to develop a theory of how the different properties of an armour material such as strength or toughness translate to its performance under blast loading. Ultimately, a key outcome of the project will be a predictive framework to identify the optimal materials for use in the armour system of ADF land vehicle platforms.

In partnership with DMTC and DST, Brodie travelled to South Africa to collaborate with the University of Cape Town and conducted more than 80 blast experiments as part of his PhD research. Brodie has travelled to conferences in Norway, France and The Netherlands to present his research, as well as presenting at universities within Australia and the United Kingdom.

Brodie has worked with DST conducting blast tests in Australia as well as collaborating with the Land Engineering Agency in Defence to provide research in material characterisation and computational modelling in support of their land platform development program. With submission of his PhD, Brodie accepted a position in the Land Vehicle Survivability group at DST where he will continue his research into the response of armour materials to blast loading and ballistic impact.

MR ALAIN MORIANA

Mr Alain Moriana received his Masters in 2016 from UoW. His PhD research explores ferroelectric domain engineering through ceramics texturing for underwater acoustics applications. Currently, piezoelectric single crystals are able to achieve ultra-high piezoelectric responses in terms of sensitivity, frequency bandwidth and compactness. However, complexity and cost related to manufacture is still challenging for larger scale applications.

Mr Moriana is evaluating the manufacturability of textured piezoelectric ceramics on a large scale as an alternative to single crystal growth. A key aim is to relate templated grain growth (TGG) variables to the resultant ferroelectric domain configuration, which is significant to the piezoelectric response. Using both TGG and domain engineering, he aims to improve homogeneity within polycrystalline ceramics: improving reliability, lifetime, performance and easier industrial transition into electroacoustic transducer applications.

Mr Moriana currently works within the Institute for Superconducting and Electronic Materials at UoW's Australian Institute for Innovative Materials. In the longer term, he would like to focus on integration of different disciplines to explore potential new applications for new and existing materials.

MS SCARLET KONG

Ms Scarlet Kong is a PhD student in Materials Science and Engineering at UNSW Sydney. She received her Bachelors degree in both Chemical Engineering and Materials Science and Engineering, with honours (2017).

Ms Kong's PhD project aims to improve understanding of how crystallographic texturing influences the mechanical and piezoelectric properties of electromechanical transducer materials used in naval sonar. It involves computational micro-mechanical modelling and experimental structural characterisation methods, in particular synchrotron x-ray diffraction. The project will contribute to the development of next-generation piezoelectric ceramics that can be used in underwater acoustic transducer applications.

Ms Kong has received several awards, including the Australasian Corrosion Association Prize (2015), the Perfect Engineering Prize (2016), the Hugh Muir Prize (2017) awarded by the School of Materials Science and Engineering, and an award for her honours thesis presentation, given by Materials Australia (2017). She was also the recipient of a Summer Research Scholarship to study at NCSU (2014), the AINSE Honours scholarship (2017) and the ANU Summer Research Scholarship (2017). Ms Kong is currently a student ambassador for the Faculty of Science at UNSW Sydney.

OVERSEAS EXPOSURE

DMTC has partnered with Thales to provide two PhD candidates the unique opportunity to work on leading edge, industry relevant research projects, coupled with the opportunity for international experience and exposure. DMTC worked with Thales in Australia and France to identify a research area, strategically important to Thales business units across the globe. As a follow on from DMTC's existing single-crystal piezoelectric sonar materials project, the study of the next generation of these materials was identified as a key area of research interest.

This research will be undertaken between DMTC, Thales Underwater Systems Australia, Thales Research and Technology – France, Thales Defence Mission Systems – France, UoW and UNSW. This will provide two DMTC PhD scholarship recipients, Ms Scarlet Kong (UNSW) and Mr Alain Moriana (UoW), the opportunity to spend time at overseas research labs and gain valuable international experience and networks. DMTC is looking to replicate this model for future DMTC scholarships with defence industry partners that have an international footprint.

In the reporting period, DMTC continued to focus on the successful delivery of R&D outcomes across a portfolio of new and existing programs to address critical Defence and industry capability challenges. Ongoing engagement with Defence enabled the establishment of new, industry-focused technology R&D activities. Significant progress was made in the delivery of the newest programs, namely MCM and HASS.

DMTC received a portion of its income from the Defence Strategic Policy & Intelligence Group. Through the co-investment model, this funding was leveraged with additional cash and in-kind contributions from Australian industry, research agencies, State Government and other Defence Program sources.

Revenue for the financial year totaled $22.9m, reflecting a Compound Annual Growth Rate (CAGR) of 10% over the past four years. Total revenue included $13.5m of in-kind contributions from industry and research partners. In-kind contributions from industry and research partners exceeded commitments by 14.7% for the year, reflecting our partners' continued support for and willingness to engage in DMTC activities.

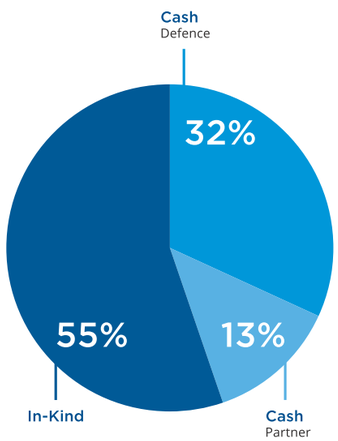
DMTC is well positioned to respond to new and emerging technologies as a result of both its business model and careful management of committed funds. The timing and cash flow implications of strategic Investment decisions and related payments resulted in a minor deficit of $56k for the year ending 30 June 2018.

Cash reserves totaled $13.5m at 30 June 2018 and included $11.4m of unearned revenue, from Defence, CSIRO and DST. These funds have been committed to fulfil existing and new research activities in future periods under the Commonwealth Agreement, Defence program contracts, the MCM Program and the HASS Program.

Copies of the company's statutory financial report for the year ending 30 June 2018 are available on request.

ACROSS THE DECADE

TOTAL
$183.54 MILLION



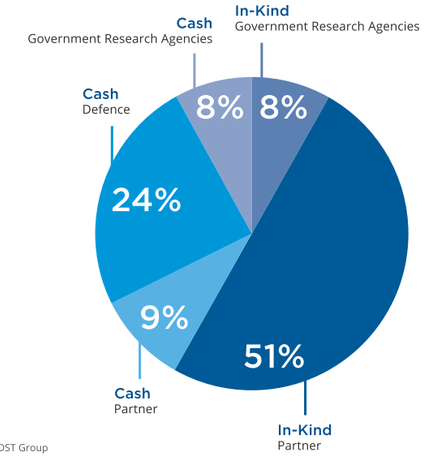
* In-Kind includes Partner and Defence contributions

YEAR IN SUMMARY

RESOURCES **RECEIVED**

TOTAL
$22.91 MILLION

Cash
$9.44 MILLION



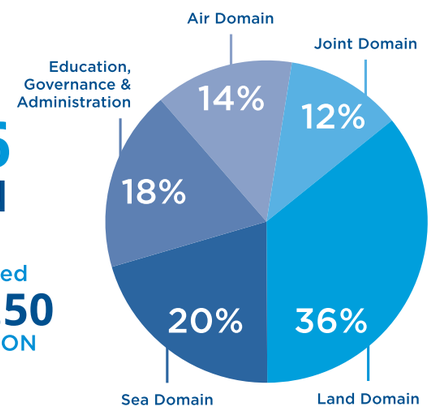
* Government Research Agencies includes CSIRO and DST Group

RESOURCES **APPLIED**

TOTAL
$22.96 MILLION

In-Kind Applied
$13.46 MILLION

Cash Applied
$9.50 MILLION



* Air Domain includes HASS
* Joint Domain includes Enabling Technologies and Industry Capability Development
* Land Domain includes Medical Countermeasures

MANAGEMENT Team

DR MARK HODGE
Chief Executive Officer

MR JIM ARTHUR
Chief Operating Officer

MR STEVE EVANS
Chief Financial Officer

MR DEEPAK GANGA
Lead Program Manager &
Land (Dismounted) Program Leader

DR STEPHEN VAN DUIN
Maritime Program Leader

DR KIMBERLEY CLAYFIELD
High Altitude Sensor
Systems Program Leader

DR MATT DARGUSCH
Chief Technology Officer &
Air Program Leader

DR FELICIA PRADERA
Medical Countermeasures
Program Leader

DR MARTIN VEIDT
Enabling Technologies
Program Leader

MR JAMES SANDLIN
Program Development Manager

MS CHARLOTTE MORRIS
Industry Capability Development
Program Leader

MS BRONWYNNE MCPHERSON
Executive Coordinator

MR MILES KENYON
Program Development Manager &
Education Program Leader

MR GARY SAVAGE
Land (Mounted) Program Leader

MS ELISA WOODLOCK
Information, Quality &
Program Support Officer

MS ANTHEA SILOM
Management Accountant

MR HARRY BAXTER
Communications Manager

GOVERNANCE
Corporate Responsibility

The DMTC Board is responsible for overseeing the management and strategic direction of the Company. Each Director is elected for a two-year term by the Company's Members at the AGM. As required by the company's Constitution, the Directors have a comprehensive and complementary range of skills and experience covering areas such as Defence systems and procurement, education and research, financial and risk management and corporate governance.

AGM AND PARTICIPANT WORKSHOP

The DMTC Participant Workshop was held on 9 November 2017. The workshop provided participants with an update on the Company's ongoing and planned program activities. The DMTC AGM was also held on 9 November, immediately after the Participant Workshop. Members of DMTC provided unanimous endorsement of DMTC's Strategic Plan as well as new, existing and planned activities. In accordance with the company constitution, Directors Mr Tony Quick, Dr John Best and Professor Valerie Linton retired by rotation at the meeting and were subsequently re-elected to the Board of Directors.

AUDIT, RISK AND REMUNERATION COMMITTEE

The Audit, Risk and Remuneration Committee is a formal subcommittee of the Board. The Committee assists the Board in its decisions on financial reporting, internal control structures, internal and external audit functions, compliance, governance and risk management systems and remuneration policies.

The Committee is comprised solely of nonexecutive Directors of DMTC, the majority of whom are independent.

ADVISORY PANELS

The Higher Education Advisory Panel's charter is to provide advice to the CEO on a range of matters relevant to the higher education sector, including factors relating to research impact, higher education policy and institutional priorities, and the development of strategically important research capability. The Panel met three times during the year with the scope of deliberations including:

- development of an appropriate research impact framework
- updates on the rollout of the Defence Innovation System and Defence-related training initiatives
- potential and proposed new technology themes and programs for DMTC
- Information security and IP management
- developing, maintaining and growing DMTC's Education Program.

ENVIRONMENTAL AND SOCIAL CAUSES

The DMTC Management Team continues to work towards minimising its environmental footprint and demonstrating its ongoing commitment to corporate social responsibility. Actions taken in the company's head office during the reporting period, in line with the company's environmental policy include procurement of recycled office paper, eliminating avoidable business travel and purchasing carbon offsets for corporate air travel. More broadly, individual members of the management team are engaged in corporate volunteering programs. DMTC procures administrative supplies and corporate communications material through social enterprises where possible and is also proud to sponsor several academic prizes and charities.

PROUD SUPPORTER OF SOLDIER ON

Nadrasca Diversity in Industry

BOARD
of Directors

MR TONY QUICK
Chair
MA (University of Cambridge)

DR ROGER LOUGH AM
Deputy Chair
PhD (University of Adelaide),
FTSE, GAICD

MRS BRONWYN CONSTANCE
Director
FCPA (Australia), FCIS, FAICD

DR PETER JONSON
Director
BCom, MA (Melbourne),
PhD (London School of Economics)

MR MICHAEL GROGAN
Director

PROFESSOR VALERIE LINTON
Director
PhD (University of Cambridge),
MBA (La Trobe University), FIEAust

DR JOHN BEST
Director
PhD (University of Wollongong),
BSc (Hons) (University of Queensland),
MBA (University of Adelaide), GAICD

The biographies of DMTC Board members are available from www.dmtc.com.au

QUALITY Management

Along with meeting physical and information security obligations, retention of quality system accreditation is a key reputational asset for DMTC in its engagements with the Department of Defence and, more broadly, in its work in the Australian defence sector.

The achievement of ISO 9001:2015 accreditation by the company in 2017 has been reaffirmed in the first of the annual audits required to retain the accreditation. The ISO benchmark represents a genuinely independent validation of our systems and processes.

The external accreditation of DMTC's quality management system sits alongside, and is complementary to, a range of existing, internal continuous improvement (CI) commitments.

Through both of these initiatives, DMTC continues to maximise the effectiveness and efficiency of its program delivery activities, and its supporting corporate systems and operations.

DMTC's partners and State and Federal Government agencies alike can have confidence that our focus remains in delivery of practical, tangible outcomes for Defence capability and for the defence industrial sector.

Building on its six years of involvement in the internationally-benchmarked Supplier Continuous Improvement Program, administered in Australia by the Centre for Defence Industry Capability, DMTC has continued to conduct annual self-assessments. These are useful as a 'health-check' on the organisation and to test the strategic focus and alignment of ongoing CI activities.

DMTC continues to perform strongly, improving its self-assessment result in 2018 and confirming its commitment to delivering value to its industrial and research partners.

> "The rigour and discipline involved with implementing and maintaining a quality system provides DMTC with an internationally recognised benchmark on our business systems, delivering confidence to our partners and customers that our planning and execution of programs is as effective as possible."
>
> **Dr Mark Hodge**
> **CEO, DMTC**

Pictured: RAAF Air Warfare Instructor Flight Lieutenant Michael Pickering, and Air Battle Manager Flying Officer Stephanie Geaney monitor the airspace in the Control Reporting Centre at Nellis Air Base, Nevada.

GLOSSARY

ADF	Australian Defence Force
AGM	annual general meeting
AiG	Australian Industry Group
ANSTO	Australian Nuclear Science and Technology Organisation
APS	Air Plasma Spray
APU	auxiliary power unit
ASW	anti-submarine warfare
CDIC	Centre for Defence Industry Capability
CBR	chemical, biological or radiological
CSIRO	Commonwealth Scientific and Industrial Research Organisation
D4	double diaphragm deep drawing
Defence	Australian Defence Organisation
DICP	Defence Industrial Capability Plan
DIPS	Defence Industry Policy Statement
DMTC	Defence Materials Technology Centre
DST	Defence Science & Technology
FY	financial year
GMAW	gas metal arc welding
HASS	high altitude sensor systems
HVOF	high velocity oxygen fuel
IP	intellectual property
JSF	Joint Strike Fighter
LCT	laser cladding technology
MCM	medical countermeasures
Mip	macrophage infectivity potentiator
PLC	programmable logic controller
PhD	Doctor of Philosophy
POC	point-of-care
QUT	Queensland University of Technology
RAAF	Royal Australian Air Force
RAN	Royal Australian Navy
R&D	research and development
RMIT	Royal Melbourne Institute of Technology
SME	small to medium-sized enterprise
SPD	supersonic particle deposition
SUT	Swinburne University of Technology
TGG	templated grain growth
T-GMAW	tandem gas metal arc welding
TRA	Technology Readiness Assessments
TRL	Technology Readiness Level
UoW	The University of Wollongong
UQ	University of Queensland

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