CREATING FUTURE CAPABILITY

2016 DMTC ANNUAL REPORT

DMTC DEFENCE MATERIALS TECHNOLOGY CENTRE

VISION

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

MISSION

DMTC leads, facilitates and manages cooperative research and development in the defence and related sectors in manufacturing, engineering and applied science to create and enhance Australian industrial capability. Defence and national security customers, industry and the research sector are key stakeholders.

PARTICIPANTS

DMTC is comprised of partner organisations that contribute resources towards joint 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.

MODEL

DMTC's collaborative model:

- fosters enduring collaborative relationships between prime defence contractors, SMEs, research organisations, industry bodies and Defence
- features an intellectual property model focussed on rapid royalty-free transfer to partner organisations
- simplifies the formalisation of collaboration with standardised agreements
- leverages resources of collaboration partners providing highly cost effective outcomes
- maintains and benchmarks the balance between technology excellence and commercial outcome
- delivers impact for the Defence customer and the research and industrial sectors.

CONTENTS

Front cover image: At CSIRO, thermoelectric modules are mounted on a copper hotside plate to test their output. (Photo: MB)

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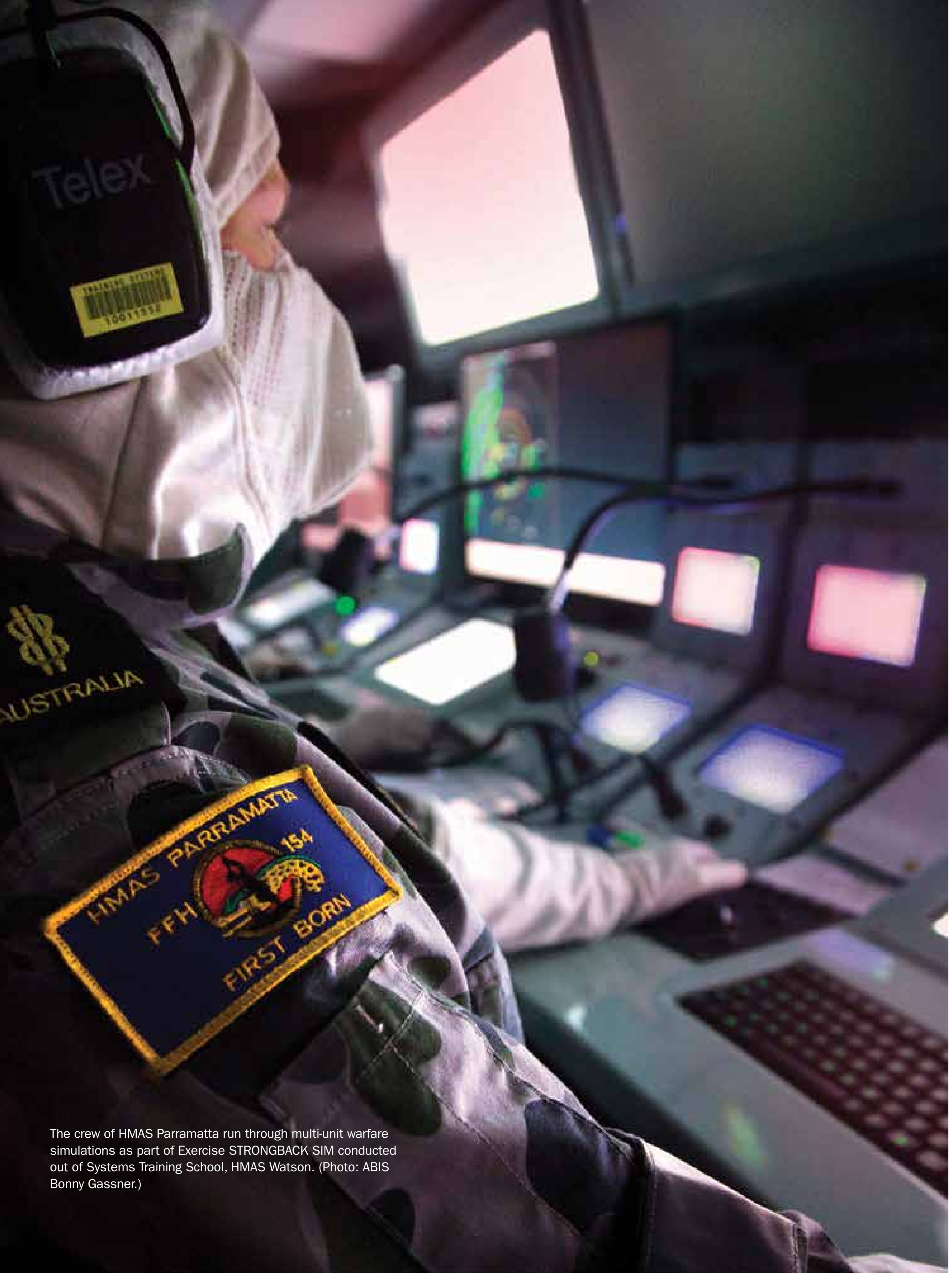


The crew of HMAS Parramatta run through multi-unit warfare simulations as part of Exercise STRONGBACK SIM conducted out of Systems Training School, HMAS Watson. (Photo: ABIS Bonny Gassner.)

MINISTERIAL FOREWORD

The Prime Minister of Australia, the Hon. Malcolm Turnbull, has put innovation, science and research at the centre of the Australian Government's agenda. This commitment is incredibly important not only to our national economy and to our future, but also to our national security and defence.

The Turnbull Government has restored certainty through the 2016 Defence White Paper (DWP) and is delivering the largest investment to renew Defence capability in recent history.

One of my highest priorities is to ensure we have a truly collaborative national approach to developing Australia's Defence Force (ADF) capability, and to ensure Defence gets the equipment, systems and personnel it needs. It is pleasing to see that collaboration is at the forefront of DMTC's approach to working with Defence, with the research sector and with defence industry.

DMTC has already played a key role in the transformation of clever ideas into fielded capability solutions, allowing our ADF to maintain its highly prized capability edge. Building on its past successes, DMTC continues to work with Defence, as a partner in the Innovation Hub announced in the 2016 Defence Industry Policy Statement (DIPS), to align its endeavours with Defence's capability requirements and research priorities.

The DWP contained $195 billion of new investment in our Defence capabilities over the next 10 years. In my role as the Minister for Defence Industry, I am tasked with managing this massive program and I will be focussed on ensuring we support Australian industry to grasp this once-in-a-generation opportunity and ensure our plans for job creation and economic growth are realised.

I also have the privilege and opportunity to continue to advocate for the role Australia's science and research community can play in supporting and enhancing Defence capability. DMTC is one of Australia's best proponents of collaboration between these key stakeholder groups.

Innovation can come in many shapes and sizes. It can deliver everything from significant, game-changing breakthroughs in technology to incremental changes that improve the quality or efficiency of a production line or the integrity of a supply chain. It can even involve taking an already proven concept and pursuing its application in a new domain.

DMTC is working with defence companies, both large and small, to translate innovation into reality and to maximise the relevance and impact of research and development activities.

I congratulate Dr Hodge and his DMTC team for their ongoing commitment to enhancing Defence capability, and I welcome this report on their achievements over the past 12 months.

THE HON. CHRISTOPHER PYNE, MP,
Minister for Defence Industry

NATIONAL DEFENCE INNOVATION AWARD WINNER – MARITIME FABRICATION

5 PROGRAMS addressing key Defence priorities

WORKING ACROSS ALL AUSTRALIAN STATES

402 PEOPLE

directly involved in DMTC activities

57 PARTNERS

working together for a more SECURE future

PROVEN COLLABORATIVE MODEL

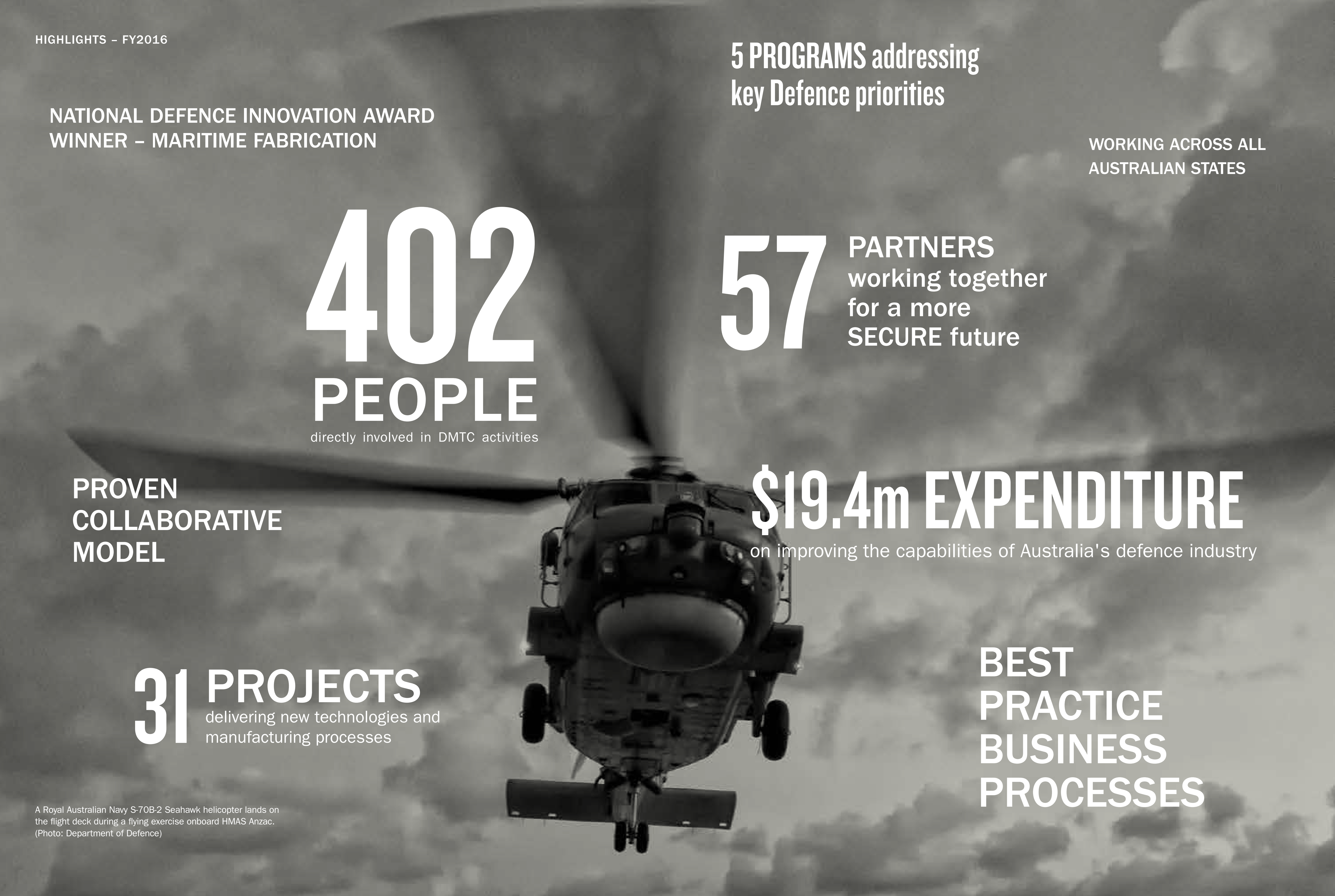
$19.4m EXPENDITURE

on improving the capabilities of Australia's defence industry

31 PROJECTS

delivering new technologies and manufacturing processes

BEST PRACTICE BUSINESS PROCESSES



A Royal Australian Navy S-70B-2 Seahawk helicopter lands on the flight deck during a flying exercise onboard HMAS Anzac. (Photo: Department of Defence)

Australian F-35A flying out of Luke Air Force Base, USA.
(Photo: Lockheed Martin)

HARNESSING INDUSTRIAL CAPABILITY

In the 2016 DWP released earlier this year, the Government reaffirmed that our military must be at the cutting edge of science and technology.

The DIPS released alongside the DWP acknowledges the fundamental contribution that Australian industry provides to defence capability, and the importance of innovation. Through the implementation of the DIPS, Defence is looking to reset and re-focus its relationships with Australian industry.

DMTC has been identified as a key partner in the new Defence Innovation Hub, and will continue to have a vital role to play in applying research and harnessing industrial capability.

Defence's decision to establish a new Industry Policy Division (with responsibility for establishing the Innovation Hub) in the Strategic Policy and Intelligence (SP&I) Group underscores the critical importance of industry and innovation to delivery of the Government's Defence policy objective. As part of the 'strategic centre' of Defence, SP&I Group has a vital role in decision-making and ensuring the alignment of Defence strategy, capability and resources. This means that our innovation investment decisions will be aligned with clear, transparent and coherent investment priorities set by Government.

Achieving and maintaining a capability edge for the ADF demands an agile approach to new ideas. Our industry sector and the research and science community must be engaged and informed so that research can commence quickly and so that the transition from research to product development and achieving capability effects is a seamless one.

Australia is fortunate to have DMTC as a key collaborative partner working with Defence, and involved as a partner in the rollout of the new Defence Innovation Hub. DMTC has already established strong working relationships with the Defence Science and Technology (DST) Group and other groups in Defence.

The relationship between DMTC and Defence is important to the success of our collective endeavours. DMTC helps Defence deliver enhanced capability outcomes by leveraging partnerships through its extensive networks and providing access to otherwise dispersed expertise across the Australian research sector.

A key feature of the new Defence innovation ecosystem is the primacy of the capability requirements of the warfighter – this ensures that there is a strong and shared focus on our ultimate customer. A single innovation pipeline is critical to minimising hand-off points and maximising the value of the Government's investments and the opportunities for Australian industry.

It is always pleasing to see excellence and expertise recognised, formally, with prestigious technology awards. Thales Australia's recent win in the 2016 Eureka Prize for Outstanding Science in Safeguarding Australia is particularly significant in the context of building local industry capability. The Hawkei vehicle is a proudly Australian capability and Thales will have the opportunity to apply many of the technological innovations introduced for the Bushmaster protected mobility vehicle, with assistance from DMTC, to the production of the Hawkei.

DMTC has successfully demonstrated its capacity to work with Defence and industry in addressing critical Defence capability challenges. I look forward to growing our highly successful and productive collaboration in the years ahead.

MS REBECCA SKINNER
Deputy Secretary, Strategic Policy and Intelligence Group, Department of Defence

INDUSTRY MAKING A DIFFERENCE

As the fourth pillar of Australia's defence and security, the defence industry needs to work effectively with the three services of the ADF, and with each other.

Collaboration is vital for lifting our defence industry capability. No single company can pull this weight, it is a collective endeavour to ensure that Australia retains its reputation as the most capable force in the region and amongst the most capable in the world.

The release of the new DWP and DIPS has the capacity to revolutionise the way Defence and industry interact, but action must be taken to make this a reality. Pledges of funding and lots of words will not be enough.

The Australian Industry Group (AiG) Defence Council has been, and will continue to be, strongly supportive of DMTC. Under the leadership of Tony Quick and Mark Hodge, the organisation has proven to be a reliable partner of choice for industry in advancing innovation across the defence sector. Their work is vital in ensuring a viable, capable and resilient defence industry that will meet the ADF's needs as well as providing the jobs of the future.

We are confident DMTC will continue to succeed, making a valued contribution to the application of ground-breaking research and deepening Australia's industrial knowledge base.

Most importantly, DMTC and the AiG Defence Council share a simple but genuine commitment – to make a difference by enhancing the capabilities available to the men and women of the ADF.

MR CHRIS JENKINS
Chair, AiG Defence Council, National Executive

A Combat Team Patrol targeting insurgent weapon caches in Oruzgan Province, Afghanistan. (Photo: CPL Ricky Fuller)

CHAIR'S REPORT

DMTC continues to occupy an important position at the intersection between Defence, defence industry and the research community. At its core, our work is about collaborating with partners to enhance defence industrial capabilities through the delivery of technologies, supply chain improvements and broader industrial capability outcomes with the Defence customer at the centre of our strategic considerations.

Across the industrial landscape, DMTC has continued to develop and mature its partnerships with research entities, established prime defence contractors and small-to-medium enterprises alike.

The release of the DWP – and with it a range of supporting documents that give effect to the overarching strategy – make 2016 a significant year for DMTC and for all in the defence sector in Australia. Our challenge is to ensure that we remain relevant and aligned to the priorities of our Defence customer and all sector stakeholders. The Defence Innovation Hub promises an end-to-end pipeline for innovation and DMTC will continue to work with Defence to realise the full potential of this and the other policy initiatives.

We recognise not only the primacy of cutting edge technology and innovation in our programs and projects, but also in the way in which our business processes add value to all of our partners and stakeholders.

In this context, DMTC's sustained achievements through our continuous improvement program are worthy of particular mention. It is evidence of the strong culture of excellence and teamwork that exists in the organisation, underpinned by an effective governance framework and rigorous financial management. The Board values this aspect of the business highly and will place a high priority on its continued development.

I am delighted that DMTC's work has again been publicly recognised, both with awards and acknowledgements. The Board views these as important validations of the value of our contribution in the sector, and of the balance we maintain between our business processes, research excellence and industrial impact from our programs. The achievements of students supported through our Education Program to pursue doctorate research are also very encouraging, and a great credit to them.

It gives me great pleasure to present the DMTC Annual Report for 2016.

Mr Tony Quick, Chair
DMTC Ltd

CEO'S REPORT

2016 was the year DMTC's transition to an ongoing business was completed. The year was predominantly about closing out the establishment contract while consolidating the new contract activities. We have seen a number of validations of the success and value of our business model over past years and, in this context, I was particularly pleased that our collaborative efforts continued to be recognised throughout the year. Most notably, our work on trialling and applying new surface ship welding and fabrication technology was highlighted as a best practice case study in the much anticipated 2016 DIPS, with other awards described elsewhere throughout this report.

The DIPS is a significant watermark in the development of the DMTC's business model as it sets out a Defence policy framework that is clear in its intent to elevate the importance of industry capability development in Defence thinking. We are anticipating significant growth in both the volume and scope of our program portfolio and continue to engage with Defence to further clarify the guidance we have received.

New activities commenced to build on our traditional focus on materials and manufacturing in the air, land and maritime sectors, commenced under the new Innovation Hub contract. In addition, DMTC embarked on a number of new activities, in some cases involving new technology fields such as medical countermeasures (MCMs) and aerospace and space sensors.

The Centre continued to grow, welcoming new industry and research institutions as Supporting Participants. Activities in the personnel survivability area have significantly matured, with several new technologies developed. This has included a new combat uniform offering superior performance, and stab-and-spike packs that offer enhanced protection. Automated off-line programming (AOLP) technology developed under DMTC activities has been licensed for commercial use, and commercialisation of the technology for curved ballistic armour shells for use in combat helmets is in progress.

The DMTC community has many strings to its bow. We solve complex technical and technological challenges. We enable innovation and the application of new technologies within and through a prime contractor's supply chains, and we work to broaden the defence industry's collective capabilities through targeted education and skills development initiatives. We do this through application of an effective, proven model, elements of which are now being sought to be applied in other areas across the Defence innovation system.

I take this opportunity to acknowledge all stakeholders involved in DMTC's journey, most particularly our Defence, industry and research sector partners who continue to reaffirm confidence in the DMTC model, and in Australian industrial capability for the defence sector. I am incredibly proud of each and every member of the DMTC team, for the way they go about their business as much as for the successes we have achieved. Our Board of Directors, the management team, our sponsors in the respective government programs and the partner group have all contributed to our track record of achievement, and to positioning DMTC for future success.

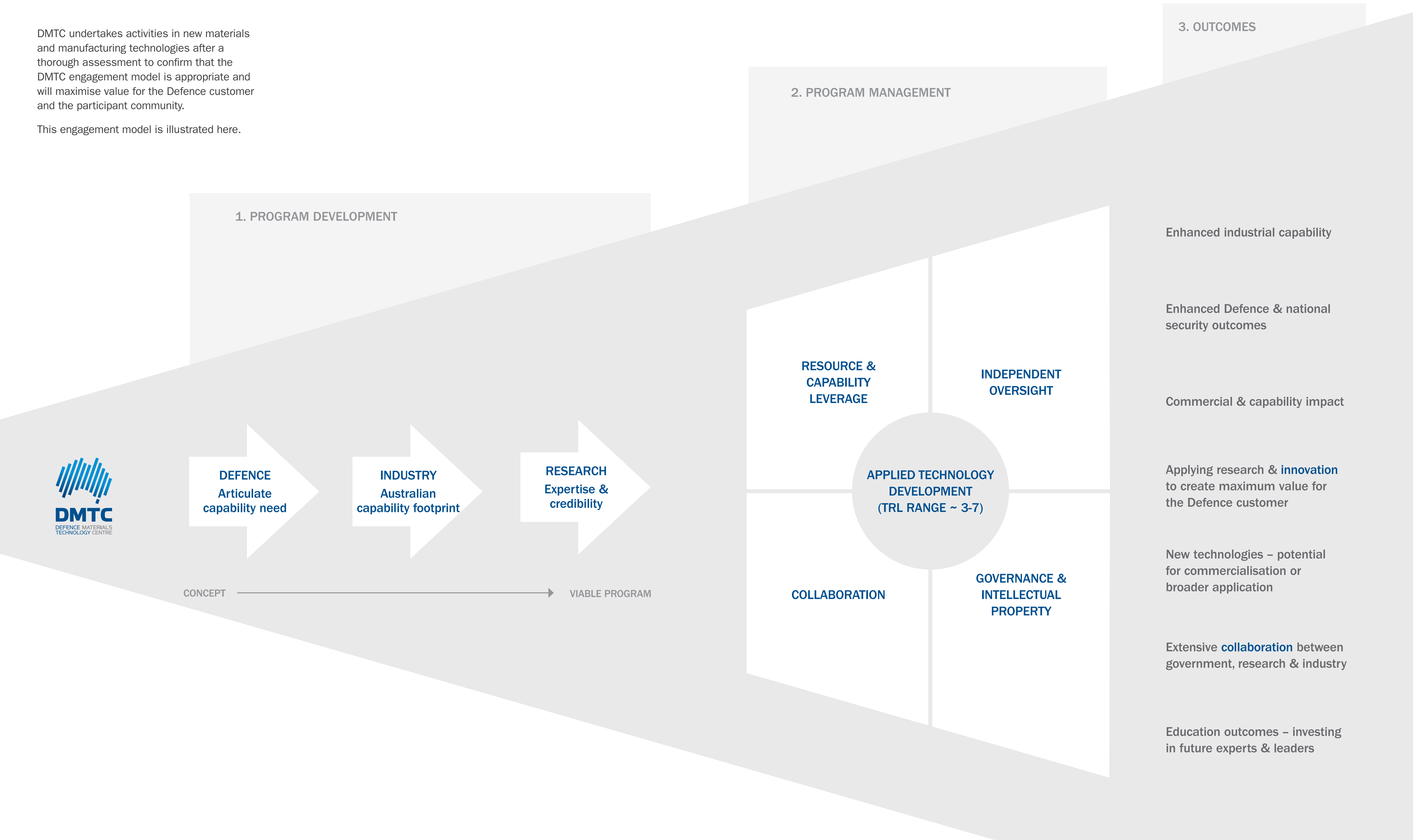
I have great pleasure in presenting this Annual Report for 2016, and commend it to you.

Dr Mark Hodge, CEO
DMTC Ltd

ENGAGEMENT MODEL

DMTC undertakes activities in new materials and manufacturing technologies after a thorough assessment to confirm that the DMTC engagement model is appropriate and will maximise value for the Defence customer and the participant community.

This engagement model is illustrated here.



DMTC IN CONTEXT

The Australian Government, in its 2016 DWP, recognised Australian industry's significant role in delivering and enhancing Defence capability and acknowledged that an internationally competitive Australian defence industry is a fundamental input to Defence capability. DMTC's role in bringing together research institutions, industry and supply chain networks is one of the keys to realising the full potential of the technology enhancements sought by Defence and, in doing so, extracting maximum value from every dollar that is invested. In the high-technology world of developing, delivering, upgrading and sustaining military capabilities and systems, industry has a particularly important role.

The DIPS, released as a companion to the DWP, notes that:

> *'The Government places a high priority on maximising the innovation potential of the Australian economy ... Innovation will be repositioned as an essential driver to generate new capabilities for Defence and new opportunities for Australian industry.'*

and that

> *'DMTC will continue to play an important part in Defence innovation and will support the new Defence Innovation Hub through its unique capabilities and networks.'*

Through the implementation of its DIPS, with links to the National Innovation and Science Agenda, Defence is streamlining its engagement with industry, academic and research organisations to establish an end-to-end innovation pipeline with a clear path to commercialisation of new technologies.

DMTC's expertise in project management and close links with stakeholders continues to ensure that research and development activities are closely aligned to Defence's priorities and directions. The technological advantage and capability edge that these projects will deliver, ensures that the ADF is well-equipped for its current tasks and well-prepared to deal with future threats and capability challenges.

Building on a traditional focus on materials and manufacturing enhancements in the Defence domains of land, sea and air, DMTC has successfully delivered innovation into major Defence projects. DMTC has already expanded beyond its initial scope, with recent program development activities in new technology areas on behalf of partners looking to take advantage of DMTC's proven methods and research expertise in programs where Defence need is coupled with an industrial capability to deliver against that need, underpinned by best practice research, development and innovation.

One example is the development of MCMs, with input from CSIRO and Defence through DST Group. Further opportunities, including in space, sensors and surveillance, are currently being assessed through engagement with the Defence customer and program definition activity with stakeholders. DMTC develops industrial capabilities that can be made available to Defence through competitive procurement channels. Through its understanding of Defence's future capability requirements, DMTC can assist Defence to fulfil its aims of earlier and more effective engagement with industry. This role in shaping and focussing industry's efforts mitigates the downstream procurement risks for Defence without compromising the core principle of best value for the Australian taxpayer.

The challenge for DMTC is to grow its networks and capabilities to support the agenda articulated in the DIPS.

"THIS [2016 DWP] IS A PLAN TO DELIVER A MORE POTENT, AGILE AND ENGAGED ADF THAT IS READY TO RESPOND WHENEVER OUR INTERESTS ARE THREATENED OR OUR HELP IS NEEDED.

IT IS A PLAN TO BECOME MORE POWERFUL ON LAND AND IN THE SKIES, AND MORE COMMANDING BOTH ON THE SEAS AND BENEATH THEM.

IT IS A PROGRAM TO BE MORE RESILIENT IN THE CYBER SPACE, TO BE MORE INNOVATIVE WITH TECHNOLOGY, AND TO HAVE GREATER SITUATIONAL AWARENESS, THANKS TO ADVANCED INTELLIGENCE CAPABILITIES."

The Hon. Malcolm Turnbull, MP, Prime Minister of Australia

An epoxy-coated sample of steel embedded in resin is inspected for degradation using a Raman Spectrometer at Queensland University of Technology (QUT). (Photo: MB)

NATIONAL DEFENCE INNOVATION AWARD FOR MARITIME FABRICATION

DMTC's work in the area of gas metal arc welding (T-GMAW) was recognised with a Maritime Australia – National Defence Innovation Award this year, an achievement subsequently commended in the DIPS. The award was presented at the Pacific 2015 Conference in Sydney and recognises companies who are leaders in technology and innovation in the defence maritime domain.

The DMTC team succeeded in applying T-GMAW as a method of addressing weld-induced distortion to improve the quality and productivity of naval manufacturing. The collaborative project, which began in 2011, was undertaken by research and industry partners including Forgacs Engineering, University of Wollongong (UoW), ANSTO and DST Group. In complex shipbuilding projects, repairs and rework due to poor welding quality and distortion can comprise up to 30% of total fabrication costs.

The DMTC project successfully addressed several weld-induced distortion issues associated with the fabrication of Air Warfare Destroyer modules, increasing productivity and weld quality and eliminating significant amounts of thermal rework. The technology and capability embodied in this award was highlighted in the DIPS as part of a case study. The DIPS further highlighted DMTC as a best practice model linking defence with industry and academia.

Dr Donghong Ding of UoW additively manufacturing using the wire arc welding process. (Photo: MB)

The award-winning DMTC project improved the quality and productivity of welding processes used to fabricate modules for the Air Warfare Destroyer, pictured here commencing Builders Sea Trials. (Photo of NUSHIP Hobart: ABET Alan Lucas)

Mr Alan Jones checks the post cladding temperature of a large component inside RMIT's laser metal deposition machine. (Photo: MB)

TECHNOLOGIES

DMTC currently operates five programs that are developing technologies, materials and processes that will enable industry to enhance Australian Defence and national security capability.

DMTC projects have historically focussed on materials, manufacturing processes and associated technologies. As DMTC continues to deliver technology improvements utilising our collaborative model, the focus is broadening to include additional areas, such as MCMs against chemical, biological or radiological threats. DMTC activity in new technical fields is undertaken after it is assessed that the DMTC engagement model is appropriate and adds value.

Areas in which DMTC facilitates projects include:

PRODUCTION, MANUFACTURING AND FABRICATION

— Machining
— Tooling
— Additive manufacturing
— Bonding and joining
— Welding
— Casting
— Automation
— Design for lightweighting
— Modelling and simulation
— Microfluidics
— Electronics
— Sensors

SUSTAINMENT TECHNOLOGIES

— Prognostic health monitoring
— Repair
— Fatigue
— Coatings
— Corrosion
— Modelling and simulation

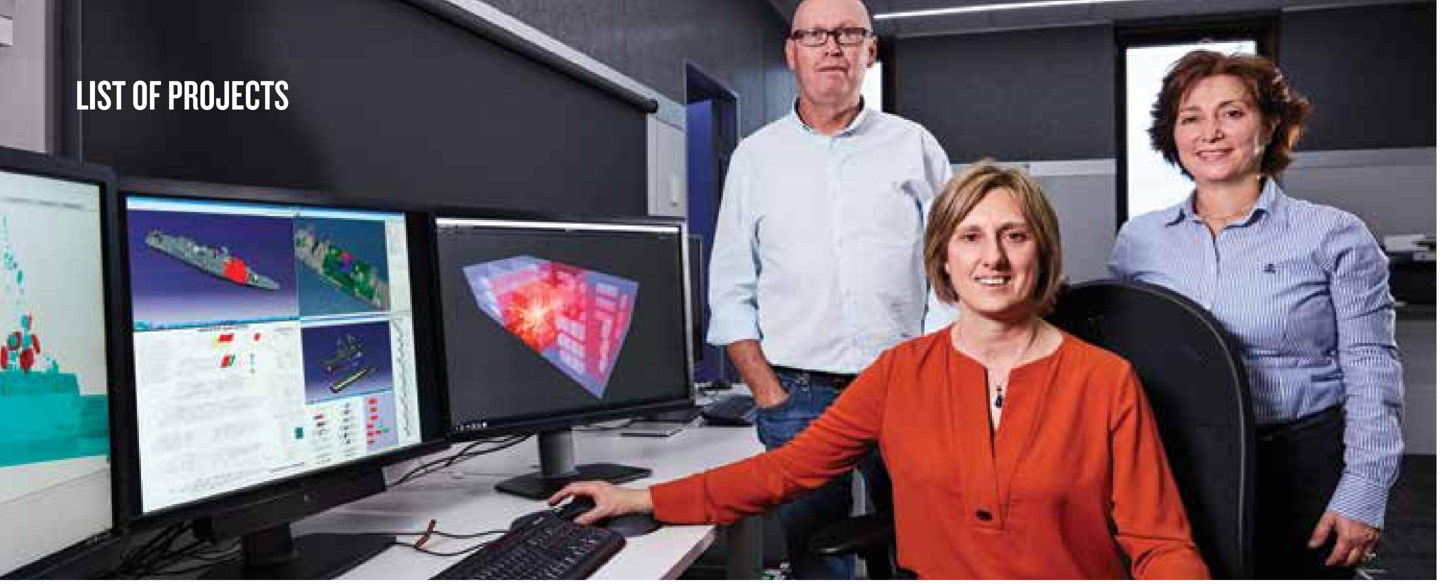
ENABLING TECHNOLOGIES

— Metals
— Composites
— High temperature
— Modelling and simulation
— Armour
— Steels
— Textiles
— Ceramics
— Piezoelectric crystals
— Power and energy
— Polyurethanes
— Molecular biology
— Cellular biology
— Microbiology
— In vitro diagnostics
— Genetics

TECHNOLOGY READINESS LEVELS

Technology Readiness Levels (TRLs) are a standardised numerical indicator system for the level of maturity of a technology. TRLs provide a common language to describe the status of a technology in development, ranging from the lowest level of TRL 1 (identification of an idea or opportunity) through to TRL 9 (a fully tested product or system ready for production and/or commercial sale). DMTC projects require the TRL of the technology in question to be defined at the outset of project activity, tracked as a project advances and documented in the project closure statement. DMTC rigorously assesses TRLs in all of its project activities, including independent validation at key stages of each project. As a general guide, the bulk of DMTC's activities are in the range from TRL 3 through to TRL 7 or 8.

LIST OF PROJECTS



L to R: Mr Pat McCarthy, Ms Zenka Mathys and Ms Serap Aksu of DST Group conduct vulnerability modelling against above-water weapon attack in DMTC's Sea Program. (Photo: MB)

PROJECT NO	PROJECT NAME	TECHNOLOGY FOCUS	STATUS
SEA PROGRAM			
9.07	Corrosion scoping study	Corrosion	In progress
9.09	Biofouling and corrosion performance evaluation	Coatings and environmental performance	In progress
9.12	Additive manufacturing of ship components	Additive manufacturing	In progress
9.14	Blast and shock modelling	Modelling and simulation for LOTE	In progress
9.17	Single crystal PZT ceramics	Ceramics for sonar/advanced fabrication techniques	In progress
9.18	Polyurethanes	Polymers	In progress
LAND (MOUNTED) PROGRAM			
6.04	Land vehicle alternative material characterisation	Inter-metallic, nano-ferrous material characterisation	In progress
6.05	Alternative vehicle power packages	Power and energy	In progress
6.06	Advanced vehicle modelling	Modelling and simulation	In progress
6.30	Automated manufacturing	Joining and welding	In progress
AIR PROGRAM			
5.01	New manufacturing capability	Subtractive and additive manufacturing/design	In progress
5.02	Enhanced tooling solutions	Machining and tooling/manufacturing processes	In progress
5.03	Sustainment capability development	Repair and health monitoring	In progress
LAND (DISMOUNTED) PROGRAM			
7.1.1	Ceramic armour technology	Niche manufacturing processes - armour prototypes	In progress
7.1.2	High curvature armour systems	Niche manufacturing processes - armour prototypes	In progress
7.1.3	Low profile body armour	New ferritic materials	In progress
7.2.1	Improved anti-ballistic soft armour	Composites, textiles technologies, performance modelling, simulation and validation	In progress
7.24	Speciality armour concepts	Composites, performance modelling	Complete
7.3.1	High strength fabrics for combat clothing	Textile technologies, composites, performance modelling, simulation and validation	In progress
7.33	Advanced nanostructured fabrics for low burden personal protection	Composites, textile technologies, nano technology	In progress
7.4.1	Portable power generation	Niche manufacturing process	Complete
ENABLING TECHNOLOGIES PROGRAM			
3.19	Lightweighting	Fabrication light alloys/composites	In progress
3.20	Modelling of manufacturing processes and new coating technologies	Corrosion and light alloys	In progress
3.21	Benchmarking for best practice	Machining/Tooling/Welding/Repair	In progress
3.37	Welding high strength steel benchmarking study (Vic)	Fabrication and welding	In progress
3.39	Welding high strength steel benchmarking study (NSW)	Fabrication and welding	In progress
3.40	Welding high strength steel benchmarking study (NSW)	Fabrication and welding	In progress
MEDICAL COUNTERMEASURES PROGRAM			
10.41	Deployable high sensitivity multiplexing point-of-care (POC) diagnostic system	Diagnostics - security sensitive biological agents	In progress
10.42	Pathology lab-on-a-chip	Diagnostics - security sensitive biological agents	In progress
10.43	Rapid mobile pathogen detection and antimicrobial resistivity diagnostics	Diagnostics - antimicrobial resistance	Concept
10.44	Pharmaceutical development of antivirulence compounds against bio-warfare (BW) pathogens	Therapeutics - antimicrobial resistance	In progress

SEA

HMAS Melbourne conducting maritime security operations in the Persian Gulf and Indian Ocean during her deployment in the Middle East Region on Operation MANITOU. (Photo: ABIS Bonny Gassner)

The 2016 DWP sends a clear message about the need for a strong, viable and sustainable Australian naval shipbuilding industry, as a vital element of our nation's defence capability.

The commitment to a Naval Continuous Shipbuilding program and the unprecedented level of investment in the next generation of ships, submarines and support vessels is a huge opportunity, and a significant challenge.

DMTC is working with Defence, industry and research institutions to deliver breakthroughs in manufacturing, to integrate new technology and to enhance skills across supply chains in support of the current and future fleets.

SEA PROGRAM OVERVIEW

DMTC's Sea Program, funded by the SEA 5000 Program, is developing technologies with wide application to Defence's maritime assets. With construction of the first ship due to commence in 2020, DMTC researchers are providing advanced material options to Defence that will contribute to meeting Australia's operational and sustainment requirements.

The following four project technology areas are at the core of DMTC's established expertise, and are being further developed for the Future Frigate platform:

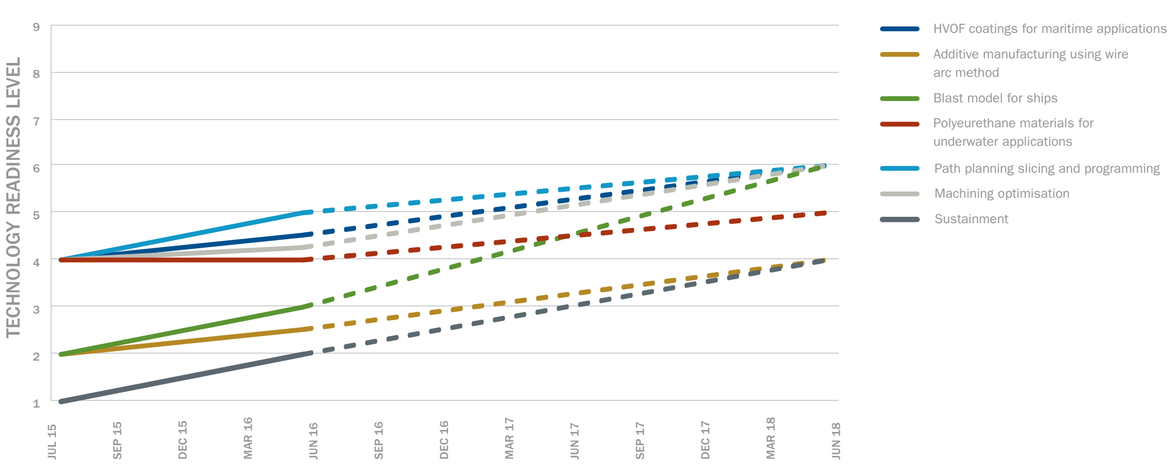
- improved understanding of corrosion, biofouling and sustainment requirements
- development of advanced welding and joining for more efficient fabrication options
- use of analytical modelling to determine ship life-of-type and life extension (LOTE)
- further development of sonar materials for a sustained in-country manufacture of advanced sonar devices

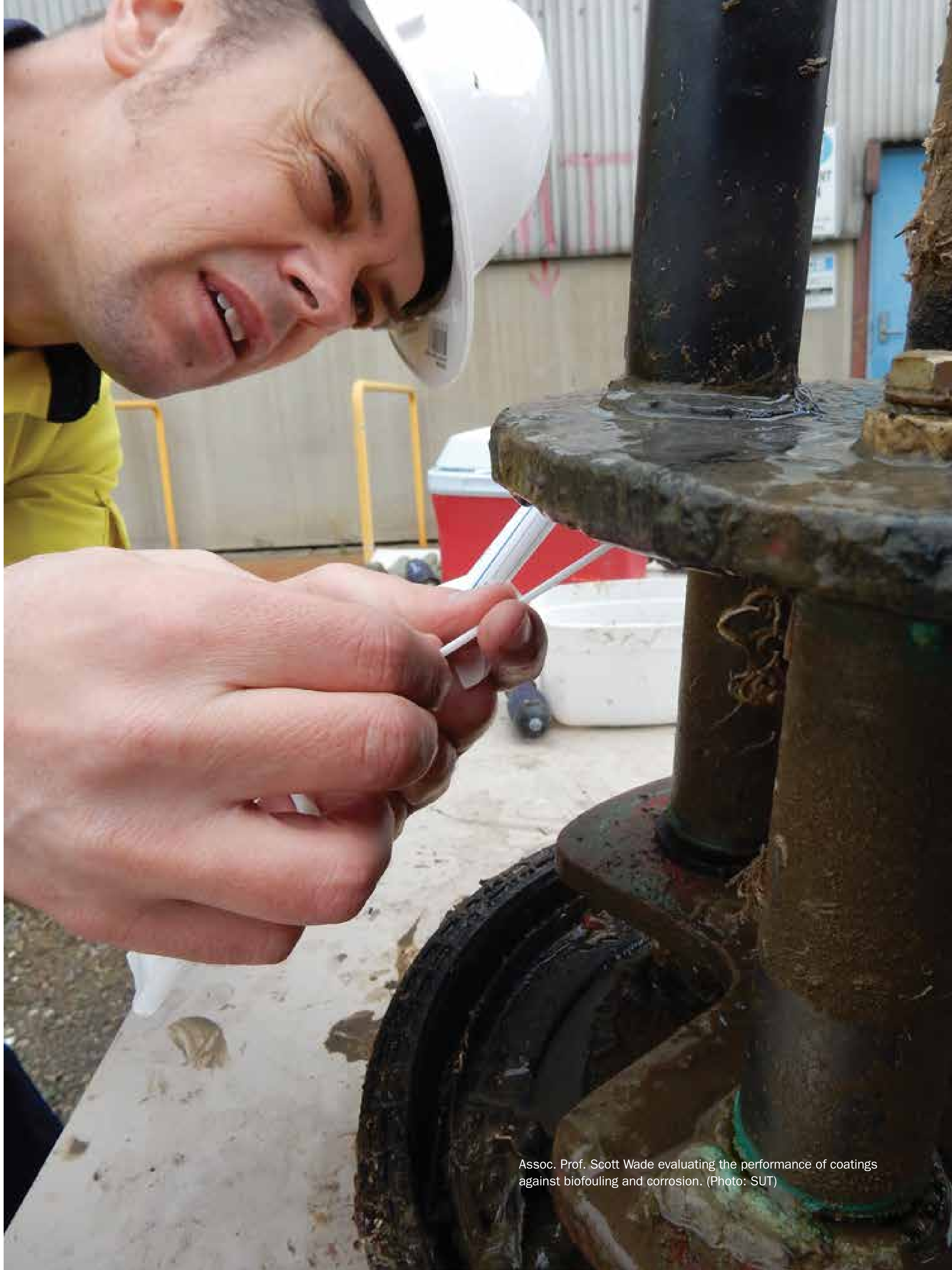
Each of these technology areas has additional application in other domains and the outcomes will potentially be applicable in the broader naval acquisition program.

While some technologies in the program are in the early stages of development, several have progressed from the laboratory to Australian field testing in order to provide an in-depth evaluation of their performance.

In other projects, an analysis of the sustainment challenges faced by the existing fleet is being used to focus research on priority areas. DMTC's Sea Program is on track to deliver outcomes to enhance Defence's maritime supply chain.

CAPABILITY DEVELOPMENT TRAJECTORY SEA TECHNOLOGIES





Assoc. Prof. Scott Wade evaluating the performance of coatings against biofouling and corrosion. (Photo: SUT)

MANAGING CORROSION IN AN AUSTRALIAN CONTEXT

Corrosion is a significant issue for the sustainment and availability of naval assets. In collaboration with DST Group, DMTC has undertaken a corrosion scoping study to determine the specific priority needs for the sustainment of naval surface ships relevant to the SEA 5000 program. This study drew upon the experience of ship maintainers, Defence operators and researchers to assess the extent of naval corrosion and determine what tools are required to detect and monitor problem areas. By analysing the cost of corrosion to Defence, researchers will be able to target the most effective areas to apply a range of prognostic and ultimately, mitigation technologies for the health management of platforms. This will assist the Royal Australian Navy with early detection and monitoring tools needed to increase the operational availability of Australia's frigates.

For marine hydraulic components, DMTC researchers from Swinburne University of Technology (SUT) and DST Group are working with defence supply chain partners United Surface Technologies and MacTaggart Scott Australia to investigate the biofouling and corrosion performance of new high velocity oxygen fuel (HVOF) thermal spray coatings. The HVOF coating process uses high kinetic energy and controlled thermal output to produce dense, low porosity coatings, that exhibit high bond strengths, low oxide content and relatively low roughness. Several field trials are underway at Australian ports and harbours to determine the corrosion performance of the coatings when immersed in water.

MATERIALS FOR NEXT GENERATION SONAR

Single crystal piezoelectric materials are the latest generation of acoustic transducer material known to improve the sensitivity of sonar equipment. This is cutting edge technology and local development is limited by issues with the supply of single crystals from overseas.

In response to increasing demand and need for supply certainty, coupled with the potential for significant enhancement of signal sensitivity, Thales Underwater Systems (TUS) Australia, UoW and ANSTO are developing single crystal growth technologies and production processes that will enable the establishment of a manufacturing capability in Australia. Researchers have successfully used the solid-state crystal growth process to efficiently produce single crystals of a size required for advanced transducer devices. Continuing research is focussed on fully characterising the crystallographic and piezoelectric properties that will enable the single crystal piezoelectric technology to be considered for commercial production.

In a separate sonar material project, The University of Queensland (UQ) and TUS are identifying possible opportunities to improve the performance of polyurethanes for transducer encapsulants. Polyurethanes are one of the most versatile plastic materials that can be manufactured by isocyanate coupling chemistries, with specific properties tailored for sonar products. Researchers are developing accelerated lifetime prediction tests in order to characterise and trial the synthesis of select polyurethane formulations. The outcome will be an industry capability to produce a range of polyurethanes material solutions for various Defence platforms.

ADDITIVE MANUFACTURING OF LARGE NAVAL COMPONENTS

Many undersea components are made from copper and nickel alloys such as Monel and nickel aluminium bronze because of their excellent corrosion and wear resistance. However, the costs associated with both the bulk material and casting methods used to manufacture and repair components made from these materials can be prohibitive, so more flexible and cost effective manufacturing techniques need to be considered. As an alternative to casting and subtractive machining, researchers from UoW, RMIT and The University of Melbourne (UoM) are working with MacTaggart Scott Australia to develop additive manufacturing techniques using the wire arc welding process.

Wire arc additive manufacturing has the advantage of high deposition rates, and when coupled with robotic automation, has an almost unlimited working volume for the manufacture of larger components. Its flexibility to rapidly attach complex smaller geometrical features onto larger cast subcomponents, or to fully build a component without using a casting at all, provides an opportunity to reduce wasted material and product lead time and eliminate casting defects.

By utilising robot programming technology previously developed within the DMTC Land Program, robot path planning can be rapidly generated directly from computer-aided design. Researchers are currently optimising the welding parameters required to produce the desired metallurgical properties for the target application, with the results indicating that the deposited alloy is suitable for full part manufacture.

LIFE OF TYPE EXTENSION OF NAVAL FRIGATES

DMTC is developing a blast and shock modelling capability to assist in the through-life assessment and management of surface vessels. This is particularly relevant for the SEA 5000 Future Frigate platform as Australia considers the service life of the new warship. The key challenges for operational and life cycle management of a platform include: how to ascertain the 'assessed age' of a current warship; how to determine whether the service life of a warship can be extended (LOTE); how to assess the condition of an aged warship from a variety of military loading events to determine whether the environmental degradation affects the military loading damage and impacts the LOTE; and how to determine which operational or management practices a warship manager can utilise to extend the warship's life.

A naval vessel is designed to operate for a certain period of time in a safe and efficient manner. In order to achieve this, an effective through-life management system for the structure is required to ensure protection against progressive failure modes and to ensure the consequences of major changes to the structural loads are acceptable. By combining the blast and shock computational modelling expertise of DST Group and ANSTO, failure modes of a ship's design can be assessed relative to the structural design and failure modes as a result of weapon attack. Additionally, researchers from the University of Tasmania's Australian Maritime College are determining how to assess the age of ships based on their operational history and computational modelling.

LAND

Technologies developed in DMTC's Land Program, such as automated off-line programming of welding robots and innovative power generation technologies, have benefited vehicles such as the Hawkei. (Photo: Thales Australia)

The ADF relies heavily on the capability edge provided by land combat and amphibious warfare capabilities. Enhancements to critical capabilities in this area will increase Australia's capacity to undertake both combat and non-combat missions.

The dismounted and mounted programs undertaken by DMTC align to Defence and Army priorities. As Army modernises its vehicle fleets and continues to adapt and improve the personal equipment and weapon systems to respond quickly to evolving operational requirements, DMTC is working with industry to apply research and introduce innovations to enhance capability solutions.

Below: Dr Minoo Naebe and Dr Aaron Seeber showcase a ceramic applique for combat helmets at Deakin University. (Photo: MB)

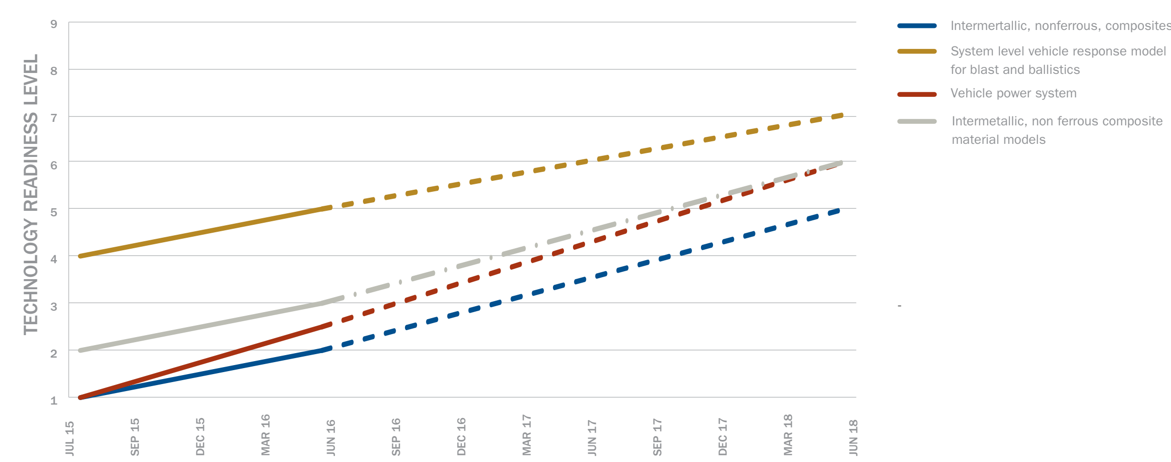
LAND PROGRAM OVERVIEW

Materials used in the land domain must be tough and reliable, enduring exposure to weather, vibration, chemicals, blunt impact and rough handling as well as potential blast and ballistic insult. The R&D undertaken in DMTC's Land Mounted and Dismounted programs aims to improve the configuration and performance of materials used in land-based systems, reducing weight wherever possible. This increases both the payload and mobility of soldiers and vehicles. Researchers are also investigating technologies to enhance the availability of electricity to soldiers to power the ever-increasing array of electronics used.

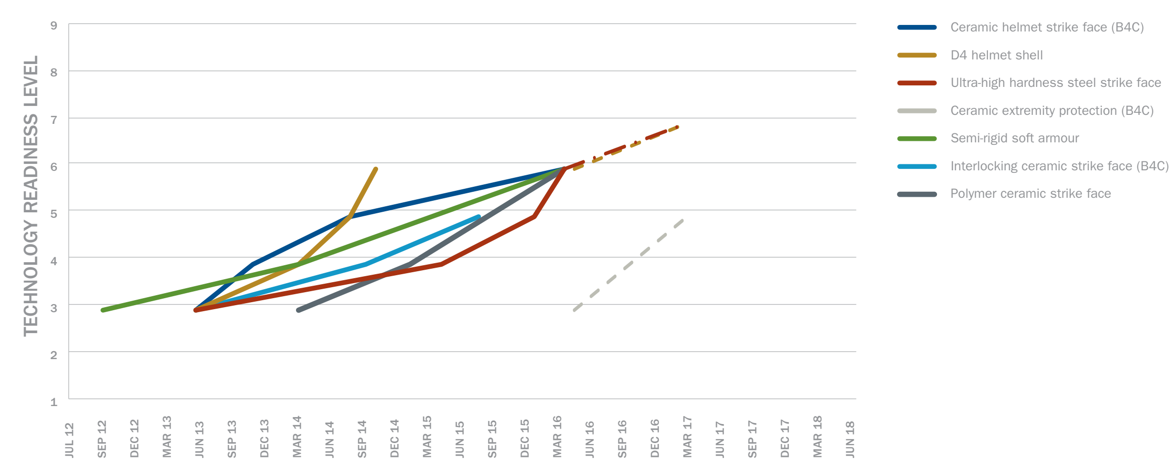
In the Land Mounted Program, four project teams are conducting vehicle research spanning nine technologies. The projects are: land vehicle alternative materials characterisation; alternative power packages for land vehicles; advanced vehicle modelling; automated manufacturing; and robotic squad support platform. This program has moved beyond its traditional areas of protection and manufacturing of land vehicles, to improve particular features of platform operation. Researchers are developing power technologies and benchmarking against existing vehicle systems to prove performance advantages. The program is investigating the development of small autonomous platforms (sub vehicle size) that can operate in concert with dismounted combatants - increasing their load carrying, mission configuration and lethality options.

The Dismounted Program research spans body armour, fabrics and power technology. Many of these projects are at a mature stage and the program has expanded its mandate to include fabrics from chemical biological and radiological (CBR) threats. Under this program, several technologies have progressed to prototype stage, including a combat helmet shell, ceramic rifle protection for helmets, portable fuel cells, lighter weight soft armour, lighter weight stab and spike armour, fragmentation resistant combat uniform fabric and quick-drying combat uniform fabric. The prototypes illustrate potential capability improvements in the areas of soldier protection and/or reduced weight.

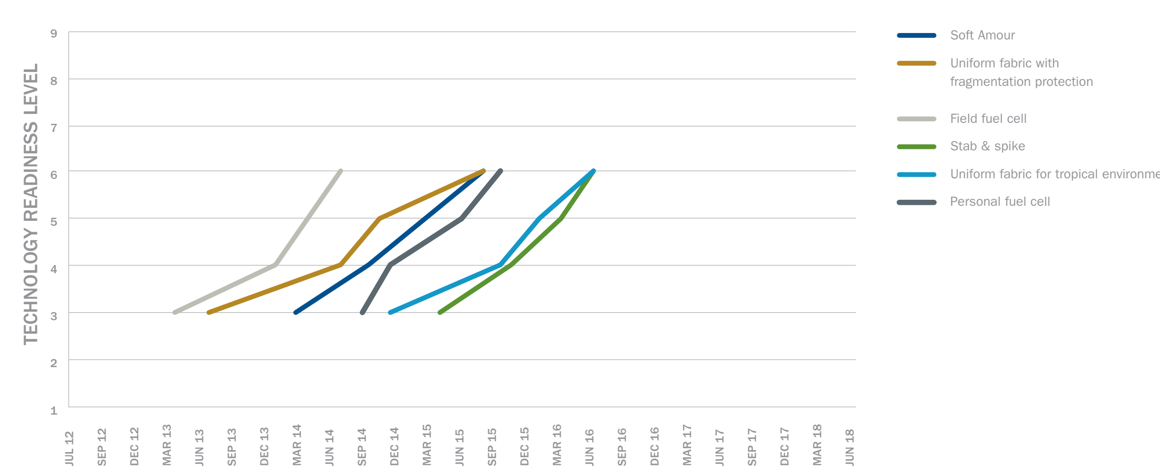
CAPABILITY DEVELOPMENT TRAJECTORY LAND (MOUNTED) TECHNOLOGIES



CAPABILITY DEVELOPMENT TRAJECTORY LAND (DISMOUNTED) HARD ARMOUR TECHNOLOGIES



CAPABILITY DEVELOPMENT TRAJECTORY LAND (DISMOUNTED) PROGRAM - FABRIC AND POWER GENERATION TECHNOLOGIES



CERAMIC APPLIQUE FOR HELMETS

Combat helmets typically provide protection against small arms fire and fragments. Rifle threats such as the AK-47 require a hard ceramic strike face to defeat. Drawing on the success of the ceramic body armour technology, DMTC researchers have developed a boron carbide helmet appliqué concept that can be attached to a helmet to protect against rifle threats.

A viscous plastic process was applied to produce a highly curved ceramic strike face with tight dimensional tolerances and a 2mm integration clearance, ideal for secure attachment onto a helmet. The outcome is an engineered solution that is substantially lighter and thinner than the commercially available alternative, while improving the protection afforded to the soldier.

LIGHTER WEIGHT STAB AND SPIKE PROTECTION

Soft body armour systems for both military and law enforcement personnel are usually designed to protect against handgun rounds and high-velocity fragments. An additional layer of armour is required to protect against stab and spike attack, typically adding weight to the overall armour system. Researchers from DST Group, RMIT, and CSIRO are developing new fabrics that are tightly woven and coated with an abrasive particle coating, making it difficult to pierce with a sharp weapon. The hybrid solution aims to offer the required level of protection while being 20% lighter than current solutions on the market.

QUICK-DRYING COMBAT UNIFORM

Research has been conducted into fabric treatments that could either reduce the amount of water absorbed by fabric or improve the ability of the fabric to shed moisture in a humid environment. The fabric treatments are effective in reducing the amount of water absorbed after immersion in water for up to 30 minutes and drip-drying for a few minutes. The amount of water that remains for evaporation is reduced to nearly half, compared with untreated fabrics. The treatment is durable and retains its efficacy for at least 25 laundry (wash/tumble dry) cycles. The treatments are equally effective for seawater and fresh water.

MORE POWER FOR MORE SYSTEMS

Researchers from RMIT and CSIRO are working with Thales and DST Group to develop a range of power generation technologies that can be applied to medium sized armoured vehicles. The project is designed to increase the power budget (generation and storage) of the platform while decreasing operational reliance on idling the engine to charge on-board batteries – saving fuel and decreasing thermal and noise signatures.

One of the technologies being developed – thermoelectric materials – converts heat to electrical energy. These materials and devices can be 3D-printed. CSIRO is working on designs that replicate hot components in vehicle engines, thereby increasing packaging efficiency and decreasing integration issues. The project aims to demonstrate the technology and show how 3D printing and thermoelectrics can be combined to improve the power generation efficiency of ADF land vehicles.

MANUFACTURING TECHNOLOGY FOR NEW PLATFORMS

The evolution of armoured vehicle design that seeks to reduce weight while maintaining occupant protection are driving changes in vehicle assembly technologies. AOLP, developed at UoW and proven on the Thales Bushmaster production line in Bendigo, is a flexible manufacturing process allowing welding robots to be programmed directly from design drawings. The technology required to do this on a lightweight tubular space frame is under development, with Thales, opening up a whole new range of potential applications for AOLP across the defence industry sector.

PORTABLE POWER GENERATION

As the number of electronic devices used by dismounted soldiers increases, so too does the requirement for portable power. Lithium-ion batteries have replaced lead-acid or nickel-cadmium batteries, which has reduced some of the burden of battery weight, however, extended operations still necessitate spare batteries or a diesel generator. A soldier on a 72-hour mission would be expected to carry up to five spare batteries.

The DMTC research team has developed a Personal Fuel Cell (PFC) that uses non-flammable fuel carried in dehydrated form, making it ideal for rugged military operational environments. Adding water (a non-volatile fuel source) turns the fuel into a liquid chemical feedstock from which hydrogen is extracted to generate electricity. The PFC produces sufficient energy to keep a single battery charged for over 72 hours. This means the PFC, can potentially replace the spare batteries at half the weight.

AIR

Air Force C-27J Spartan at RAAF Base Wagga.
(Photo: Department of Defence)

Through its Air Program, DMTC is focussing on delivering advancements in manufacturing (production) and sustainment of high-end military aircraft, including the Joint Strike Fighter. Guided by Air Force priorities and plans, including Plan Jericho, DMTC teams have worked with industry on a range of capabilities and platforms.

Ultimately, DMTC's projects will equip Australian industry with the expertise and capacity to support the RAAF and capitalise on regional and global supply chain opportunities as the future force comes to fruition.

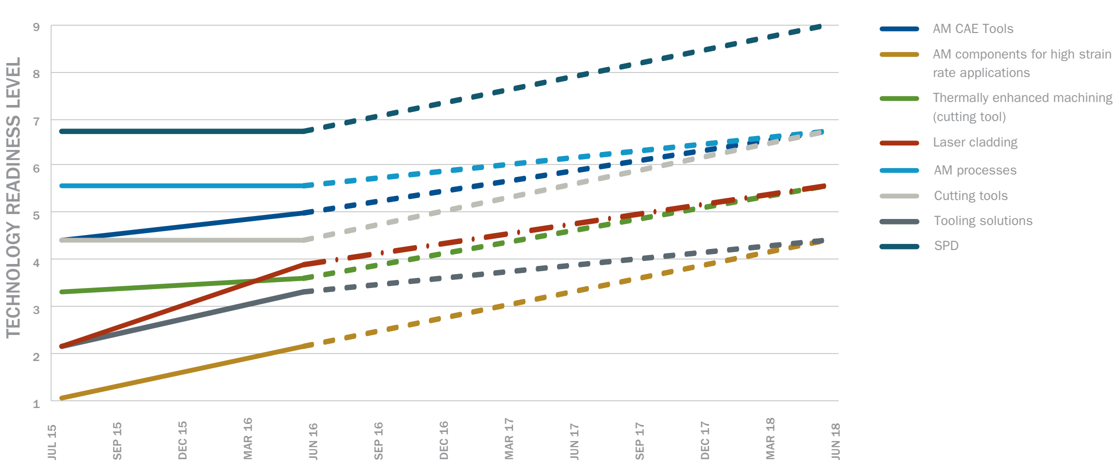
AIR PROGRAM OVERVIEW

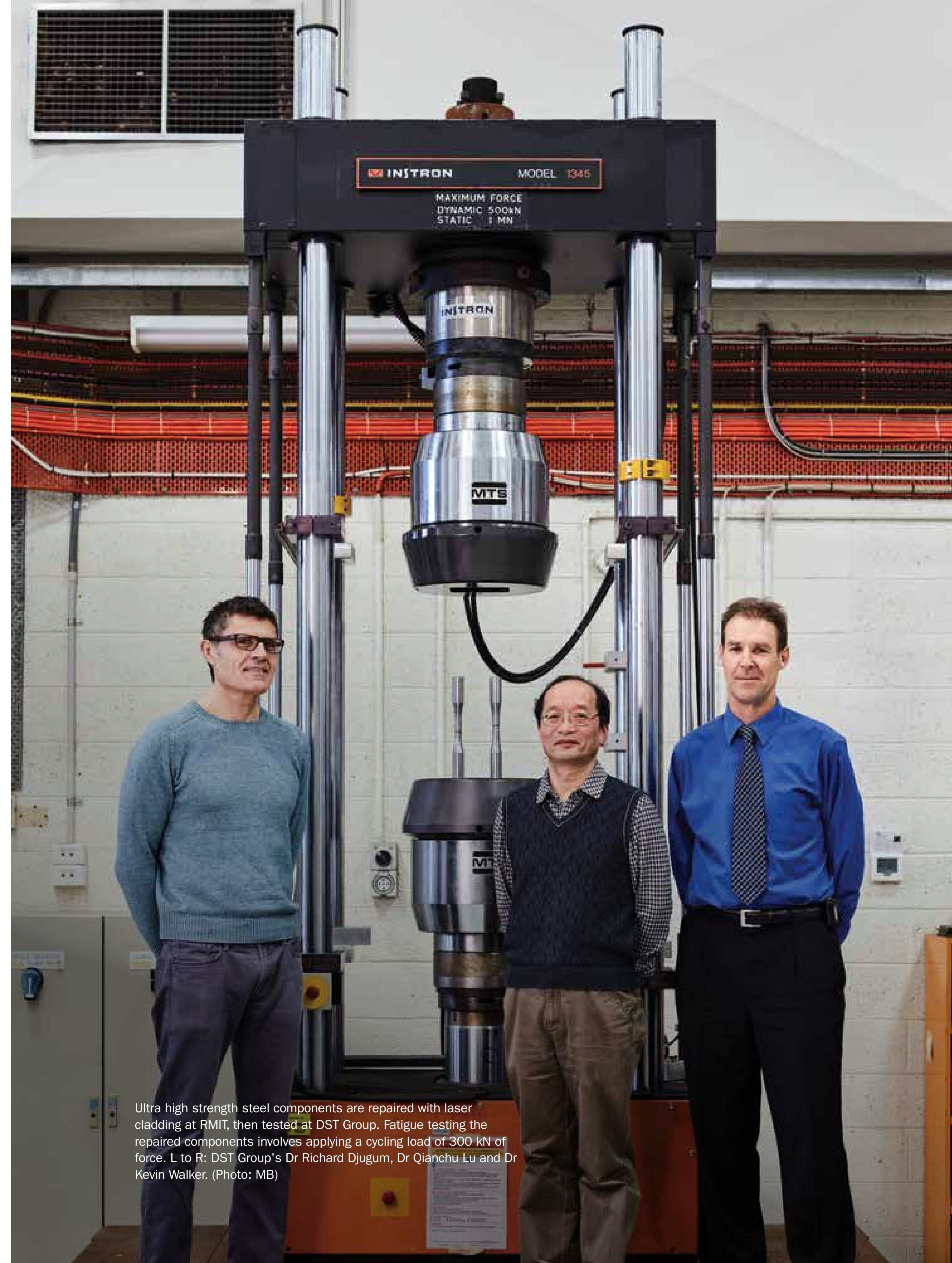
Research in this program is exploring the potential for the use of additive manufacturing for the production of components, with the potential for significant reductions in wastage, weight savings and process optimisation.

Additive manufacturing is also being explored as a method for developing a range of cutting tools used in the production of complex, difficult-to-machine components for defence applications. Tools manufactured using this technique can be customised for specific applications, delivering improved manufacturing efficiency.

In addition, laser cladding technology (LCT) for the repair of aircraft components is being investigated as an opportunity to reduce the need to remove components for repair or replacement. This will increase aircraft availability and reduce the cost of ownership of the fleets.

CAPABILITY DEVELOPMENT TRAJECTORY AIR TECHNOLOGIES





Ultra high strength steel components are repaired with laser cladding at RMIT, then tested at DST Group. Fatigue testing the repaired components involves applying a cycling load of 300 kN of force. L to R: DST Group's Dr Richard Djugum, Dr Qianchu Lu and Dr Kevin Walker. (Photo: MB)

ADVANCED MANUFACTURING PROCESS OPTIMISATION

Additive manufacturing enables complex defence-related components, such as jet engine blades, to be manufactured with minimal wastage of expensive materials.

Selective laser melting (SLM) is an additive manufacturing technology that begins with a 3D digital design. A high-powered laser beam selectively fuses fine metal powders together in a layer-by-layer method until a highly customised, 3D metal part is produced. DMTC research in this area is aimed at understanding and mitigating the known risks to implementation of this technology, particularly in structural and critical components.

Materials used in defence applications pose unique challenges for process optimisation. The project team has identified key parameters for optimisation: laser power, orientation, layer thickness and maintaining 'defocus distance' in the SLM process. Outcomes are expected to reduce cost and improve throughput.

Researchers have also commenced topology optimisation to investigate design opportunities that deliver weight savings without compromising the mechanical performance of the component, relative to manufacture by other means.

LATEST DEVELOPMENT IN CUTTING TOOLS

This DMTC project team, comprising Sutton Tools, SUT, RMIT University and UQ, is developing a range of cutting tools through additive manufacturing technologies.

The project team has manufactured cutting tool blank material by direct metal deposition (DMD), a method in which a feed nozzle introduces metallic powder into a laser beam. From the blank material, an endmill cutting tool is then produced through the grinding process. The tool is currently being benchmarked against other endmill tools obtained from standard manufacturing techniques.

The use of DMD in the manufacture of cutting tools is unique and enables the tool to be customised for a specific application. It is hoped this collaboration will develop new cutting tools for use in the production of defence components that are typically complex and difficult to machine.

ACCURATE CUTTING TOOL MODEL DEVELOPMENT

This project has successfully developed a new mechanistic modelling program and user interface for the optimisation of drill-point geometry, improving the accuracy of tools used in defence manufacturing.

Under the leadership of industry partner Sutton Tools, a team of undergraduate students set out to create a mechanistic modelling program to predict the thrust, torque and power used while undertaking drilling operations. The team's objective was to correct any errors found in previously published models and to further study and derive accurate cutting force information for the required materials.

The team ensured convergence of the models, and validated the model against production and experimental data. Finally, they used non-linear optimisation algorithms to optimise drill geometry. Based on the acquired data, the team developed an optimisation program that specifies the drill geometry with minimum thrust requirements.

A user interface was then created. The software developed is open source and the algorithms have been modified to use published data for specific cutting forces. This program has broad application beyond the specific materials tested.

Further work is required to verify the optimised drill geometry with experimental drill tests. Future models could then be expanded to include more complex drill features such as curved cutting lips as well as additional drill designs.

LASER CLADDING TECHNOLOGY FOR REPAIR

Metallic engine components and aircraft structures experience damage in operation due to a range of events including impact, wear/erosion, corrosion and cracking. This may result in the need to remove components for repair, replace the whole component or even conduct substantial structural repair, which impacts on the availability of the aircraft to the ADF as well as the cost of ownership to Defence.

Industry partner RUAG Australia has been working with DST Group and researchers from RMIT and SUT to employ LCT for the repair of components. LCT is a process that repairs a surface by first machining down the worn surface and building it back up by depositing cladding material in thin layers.

The team has identified key components for both structural and geometrical repair and are now working to optimise the LCT process parameters to achieve the strict regulatory standards required by Defence.

DST Group has undertaken repair work on the nose landing gear for the F/A-18F Super Hornet, along with mechanical properties characterisation. Experimental investigation on optimising the process parameters involved in laser cladding for repair of 300M structures has commenced at RMIT.

Similarly, experimental studies of laser cladding of 316L stainless steel on mild steel substrates is being conducted at SUT. Results indicate that there is significant variation in mechanical strength at the interface of the cladded structure. Further investigation is underway to obtain a feasible and cost-effective solution for both structural and geometrical restoration.

ENABLING TECHNOLOGIES

The Overwatch Battle Group (West) – Two at sunset during an operation in the Ad Bibdibah Desert, Al Muthanna.
(Photo: SGT John Carroll)

DMTC's track record of collaboration with the research sector and defence industry has already played a key role in the transformation of clever ideas into fielded capability solutions, allowing our ADF to maintain its highly prized capability edge.

The work done by DMTC and its highly capable participant group is at the leading edge of research and advanced materials development and opens up opportunities across a broad spectrum of applications and finished products.

Realising the potential to apply innovations across traditional boundaries is vitally important to extracting the best value from investments made in research and development activities, and to delivering the best capabilities for the Defence customer.

ENABLING TECHNOLOGIES PROGRAM OVERVIEW

The Enabling Technologies Program is tasked with developing the underpinning technologies that form the basis of many materials and manufacturing solutions required to produce an innovative and sustainable Defence industry. This program allows DMTC to invest in strategic, underpinning technical capability that will be transferred into new, specific platform-based programs in the future.

Activities this year have focussed on lightweighting technologies, corrosion assessment and protection measures along with industry engagement and benchmarking activities. The development of lightweight material solutions can provide a military capability edge across many different technology platforms to improve performance, agility, efficiency and mechanical and environmental durability. Project participants Thales Australia and DST Group are developing new material solutions that provide advantages in mass and/or functionality and have comparable mechanical and environmental performance to conventional materials. As always, cost is a major consideration when assessing the feasibility of possible solutions.

New materials for land transport applications require the development of methodologies and tools that may be applicable to other Defence platforms. These methodologies and tools include:

— establishing unified material selection processes and procedures to compare stiffness, strength, weight and environmental performance and include materials, manufacturing as well as operational costs as integral parts of the evaluation process

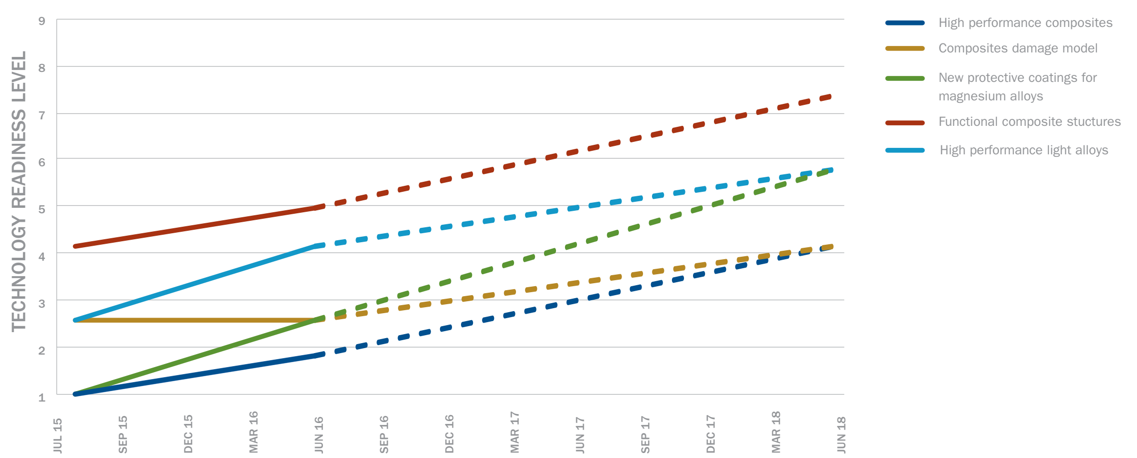
— investigating the potential of new composite manufacturing processes such as high-pressure resin transfer moulding (RTM) as cost-effective alternatives for primary composite structures. In addition, established manufacturing processes such as light resin transfer moulding (L-RTM) and vacuum-assisted RTM are investigated as manufacturing techniques for secondary components

— extending current testing methodologies to determine essential material characteristics for lightweight material solutions such as interlaminar and interface strength of fibre-reinforced composite laminates and hybrid fibre metal laminates. This includes the extension of current digital image correlation techniques to determine properties such as interface toughness, which are essential input parameters for advanced numerical simulation programs to analyse and predict the mechanical performance of alternate material solutions

— applying and validating multi-scale damage initiation and propagation simulation tools for composite materials and structures. This includes the application of advanced finite element methods such as phantom node and cohesive zone modelling techniques.

UQ's Dr Michael Heitzmann operates a phased array ultrasound with a KULA 6-axis robot to detect defects in a composite structure. (Photo: MB)

CAPABILITY DEVELOPMENT TRAJECTORY ENABLING TECHNOLOGIES



LIGHTWEIGHT MATERIALS

One of the objectives of this program is to identify and assess lightweight material alternatives at competitive costs for armoured defence platforms in general and for Thales' Bushmaster and Hawkei protected mobility vehicles in particular.

An initial materials selection study identified glass fibre-reinforced polymer (GFRP) composites as potential candidates to produce internal and external sealed storage compartments. The study compared material strength, stiffness, cost and weight performance to that of an Al 5083 321 alloy, and also encompassed material durability constraints including acid corrosion, toxicity, flammability and humidity.

Within the GFRP family, there are several possibilities that provide a spectrum of structural performance and cost characteristics. These include different fibre configurations (short-fibre, unidirectional or woven laminae) and different matrix materials (phenolic, vinyl ester and polyester). Several of these material solutions are typically used in aerospace, naval and ground transportation applications.

The small estimated batch sizes for the Bushmaster vehicle and Hawkei vehicles puts a major demand on cost-competitive manufacturing solutions. Given these constraints, L-RTM and vacuum-assisted resin transfer moulding (VARTM) are possible process candidates.

Initial material testing has identified mechanical characteristics for several potential composite material solutions. This data will be used as input parameters in finite element analysis programs to develop and validate advanced damage initiation and failure simulation models. These numerical tools are essential to design lightweight composite storage boxes that meet the mechanical requirements of the current metal solution.

ALTERNATIVES FOR METAL COMPONENT MANUFACTURING

This project team has identified several metal components of Thales' Hawkei platform that could be manufactured from alternative metal solutions, resulting in reduced manufacturing costs and possible weight savings at equal strength and durability performance.

One component being investigated in detail is the side step of the Hawkei light protected mobility vehicle. The original component is manufactured from plate-welded steel. A casting version of the component using gravity casting as an alternative manufacturing route is being considered as a way to reduce tooling costs.

Additional supply chain partners with expertise in casting have been identified. The project will create opportunities for them to collaborate with an international original equipment manufacturer who supplies equipment in all areas of Defence applications. It could become an entry point for them to gain access to the complex Defence business environment and create new opportunities to jointly develop innovative solutions.

The project has started to compare stress distributions for the current welded plate and a suggested casting design of the side step to ensure that the new part meets all mechanical requirements. Flow simulations of the casting process will then be used to provide necessary information for the tool design.

INDUSTRY CAPABILITY DEVELOPMENT

BENCHMARKING FOR BEST PRACTICE

The 2016 DIPS affirms the importance of effective collaboration between primes and companies in their supply chains, as a key contributor to a sustainable and competitive local defence industry sector.

Building on previous successful industry development activities in areas such as production of aerospace-grade titanium components from computer numerically controlled machining and additive manufacturing, a DMTC project team comprising SUT, UQ and UoW has been working with several SMEs in the Latrobe Valley, Victoria, to enhance capabilities in the welding of high-strength steels.

This is a capability that may be applied to the welding of defence components. Supported by the Latrobe City Council, this benchmarking exercise has the potential to open up significant new opportunities for manufacturers from the region to participate in future Defence projects, and has provided a greater understanding of maritime and submarine fabrication applications. Participants have gained exposure to innovative technologies, best practice techniques and processes and insights into quality, safety and certification standards expected by Defence.

Following funding commitments from the Queensland and New South Wales State Governments, the successful welding and fabrication benchmarking activity in the Latrobe Valley has been followed by new programs in the Mackay and Illawarra regions.

Industry capability benchmarking and development activities will be offered in Tasmania from early 2017, and planning is underway to run similar activities in South Australia. DMTC is also planning future activities to benchmark and enhance local industrial capability in corrosion management and new developments in additive manufacturing.

MEDICAL COUNTERMEASURES

Planet Innovation's Nplex point of care diagnostic system will enable fast, accurate diagnosis of infectious diseases while out in the field. (Photo: MB)

MCMs is an exciting new program of work for DMTC, building on extensive research already undertaken by our government, industry and research partners.

This critical work aligns with national and international efforts to protect against both CBR hazards, as well as threats and emerging infectious diseases and pandemics.

Dealing with risks to ADF personnel but also potentially to the general public, DMTC's program will position Australia to become a regional leader and centre of expertise, harnessing expertise and resources from across civil and military domains to develop an effective capability in MCMs.

MEDICAL COUNTERMEASURES PROGRAM OVERVIEW

MCMs include vaccines, therapeutics and diagnostics for the protection of military and civilian personnel against CBR threats, emerging infectious diseases and pandemics.

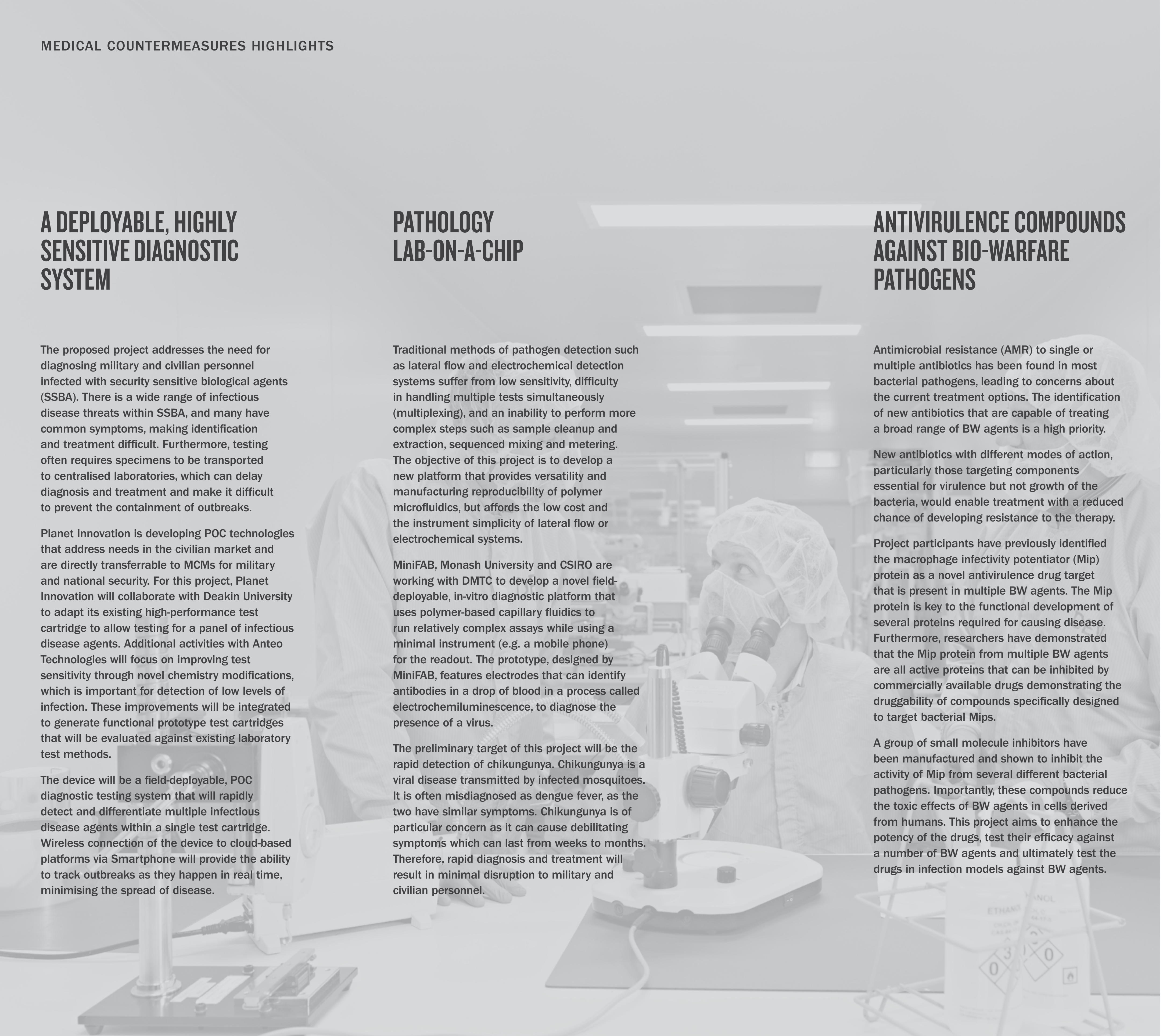
The parameters of DMTC's MCMs program were identified during the year in close consultation with Defence, CSIRO and the Medical Technologies and Pharmaceuticals Growth Centre.

The program will aim to reduce dependence on imported products and offshore capability for protection and will focus on the development of advanced technologies relevant to the national preparedness strategy. It is the result of extensive work carried out by DST Group, CSIRO and various industry and academic partners.

While Australia's discovery and development community is dispersed and relatively discrete in scope, it is highly experienced, with expertise and resources relevant to MCMs product development. Furthermore, Australia is geographically positioned as a sentinel for emerging infectious disease threats and has the potential to become a regional leader in MCMs development.

DMTC's MCMs program will create an integrated multidisciplinary network focussed on MCMs product development. Initially, it will focus on three key areas: point-of-care (POC) diagnostics; antimicrobial resistance; and security sensitive biological agents.

Dr Erol Harvey of MiniFAB heads a team which has developed a prototype pathology lab-on-a-chip that can diagnose the presence of chikungunya virus. (Photo: MB)



A DEPLOYABLE, HIGHLY SENSITIVE DIAGNOSTIC SYSTEM

The proposed project addresses the need for diagnosing military and civilian personnel infected with security sensitive biological agents (SSBA). There is a wide range of infectious disease threats within SSBA, and many have common symptoms, making identification and treatment difficult. Furthermore, testing often requires specimens to be transported to centralised laboratories, which can delay diagnosis and treatment and make it difficult to prevent the containment of outbreaks.

Planet Innovation is developing POC technologies that address needs in the civilian market and are directly transferrable to MCMs for military and national security. For this project, Planet Innovation will collaborate with Deakin University to adapt its existing high-performance test cartridge to allow testing for a panel of infectious disease agents. Additional activities with Anteo Technologies will focus on improving test sensitivity through novel chemistry modifications, which is important for detection of low levels of infection. These improvements will be integrated to generate functional prototype test cartridges that will be evaluated against existing laboratory test methods.

The device will be a field-deployable, POC diagnostic testing system that will rapidly detect and differentiate multiple infectious disease agents within a single test cartridge. Wireless connection of the device to cloud-based platforms via Smartphone will provide the ability to track outbreaks as they happen in real time, minimising the spread of disease.

PATHOLOGY LAB-ON-A-CHIP

Traditional methods of pathogen detection such as lateral flow and electrochemical detection systems suffer from low sensitivity, difficulty in handling multiple tests simultaneously (multiplexing), and an inability to perform more complex steps such as sample cleanup and extraction, sequenced mixing and metering. The objective of this project is to develop a new platform that provides versatility and manufacturing reproducibility of polymer microfluidics, but affords the low cost and the instrument simplicity of lateral flow or electrochemical systems.

MiniFAB, Monash University and CSIRO are working with DMTC to develop a novel field-deployable, in-vitro diagnostic platform that uses polymer-based capillary fluidics to run relatively complex assays while using a minimal instrument (e.g. a mobile phone) for the readout. The prototype, designed by MiniFAB, features electrodes that can identify antibodies in a drop of blood in a process called electrochemiluminescence, to diagnose the presence of a virus.

The preliminary target of this project will be the rapid detection of chikungunya. Chikungunya is a viral disease transmitted by infected mosquitoes. It is often misdiagnosed as dengue fever, as the two have similar symptoms. Chikungunya is of particular concern as it can cause debilitating symptoms which can last from weeks to months. Therefore, rapid diagnosis and treatment will result in minimal disruption to military and civilian personnel.

ANTIVIRULENCE COMPOUNDS AGAINST BIO-WARFARE PATHOGENS

Antimicrobial resistance (AMR) to single or multiple antibiotics has been found in most bacterial pathogens, leading to concerns about the current treatment options. The identification of new antibiotics that are capable of treating a broad range of BW agents is a high priority.

New antibiotics with different modes of action, particularly those targeting components essential for virulence but not growth of the bacteria, would enable treatment with a reduced chance of developing resistance to the therapy.

Project participants have previously identified the macrophage infectivity potentiator (Mip) protein as a novel antivirulence drug target that is present in multiple BW agents. The Mip protein is key to the functional development of several proteins required for causing disease. Furthermore, researchers have demonstrated that the Mip protein from multiple BW agents are all active proteins that can be inhibited by commercially available drugs demonstrating the druggability of compounds specifically designed to target bacterial Mips.

A group of small molecule inhibitors have been manufactured and shown to inhibit the activity of Mip from several different bacterial pathogens. Importantly, these compounds reduce the toxic effects of BW agents in cells derived from humans. This project aims to enhance the potency of the drugs, test their efficacy against a number of BW agents and ultimately test the drugs in infection models against BW agents.

CONCEPTS*

RAPID MOBILE PATHOGEN DETECTION AND ANTIMICROBIAL RESISTIVITY DIAGNOSTICS

The proposed project aims to demonstrate a handheld diagnostic device that would rapidly detect the presence of pathogens from a clinical sample. Based on chemiresistor technology, this 'smart' Petri dish could dramatically accelerate the typical 24-to-48-hour bacterial culturing process to within an hour. This would enable a fast, species-targeted antibiotic response at the POC.

A unique CSIRO-patented technology of chemical sensors allows electrical detection before visual detection of pathogenic bacteria is even possible. The chemiresistor can identify the highly sensitive (parts-per-billion level) molecular fingerprint associated with specific pathogens, resulting in faster and more accurate diagnostics. The sensors are low-cost, disposable, and well suited to large-scale manufacturing using photolithography, inkjet printing and liquid handling robotics.

With expert technical advice from DST Group, the project team would assess the feasibility of transferring the technology to an operational setting, which could lead to the design, fabrication and field-testing of a complete detection system in collaboration with medical device manufacturer Trajan Scientific and Medical and designer/developer Hydrix.

OTHER RESEARCH AREAS

During the process of identifying relevant projects under the MCMs program, DMTC received a number of high-quality responses addressing antimicrobial susceptibility, clinical trials for infectious pathogens and therapeutic manufacturing improvements. With recent additional funding into the program, DMTC will be able to proceed with some of these concept projects, and will continue to identify new projects to address the program themes.

*Concepts currently in development for phase II

Mr Peter Kabakov of Ansto with single crystal samples for the production of piezoelectrical elements. Mr Kabakov won a DMTC 2016 Early Career Award. (Photo: MB)

DMTC ANNUAL CONFERENCE 2016

Around two hundred delegates met in Canberra for DMTC's Annual Conference, held at the Australian Academy of Science on 16 March and was followed by a gala dinner at the Australian War Memorial.

The then Minister for Defence Materiel and Minister for Veterans' Affairs, The Hon. Dan Tehan MP, addressed delegates, highlighting the opportunities for DMTC participants and the Government's commitment to defence capability over the next decade.

Minister Tehan noted that Defence and defence industry would be at the forefront of the Government's 2016 DWP pledge to advance Defence capability with an investment of $195 billion across the decade to 2025-26.

Minister Tehan also highlighted that DMTC would play a significant role in how Defence and industry collaborate to deliver the Government's ambitious program of works.

Keynote speakers included Ms Kate Louis, First Assistant Secretary of the Defence Industry Policy Division; Air Vice Marshal Mel Hupfeld, Acting Chief of the Capability Development Group; Dr Todd Mansell, Chief of the Joint and Operations Analysis Division at DST Group; and Mr Peter Croser, Director General Specialist Ships Acquisition, Capability Acquisition and Sustainment Group.

Delegates were updated on the latest project activities and achievements across current programs, and introduced to DMTC's new program area – MCMs. Guest speaker Mr John O'Callaghan from the AiG Defence Council addressed diners at the gala evening and an auction of military art during the dinner raised funds for charities Mates4Mates, Soldier On and Legacy.

"DMTC ITSELF OFFERS A GREAT EXAMPLE OF WHAT CAN BE ACHIEVED THROUGH CLOSER COLLABORATION BETWEEN DEFENCE AND INDUSTRY."

The Hon. Dan Tehan, MP, Former Minister for Defence Materiel.

2016 DMTC AWARDS FOR EXCELLENCE

The 2016 DMTC Awards for Excellence were presented at DMTC's gala event to commend significant contributions made by individuals and teams that have yielded successful outcomes for DMTC and its participants.

Industry Partnership Award

Awarded to Dr Andrew Ang, Swinburne University of Technology

This award recognises researchers whose efforts have significantly contributed to the capability of a DMTC Industry Participant.

Research Collaboration Award

Associate Professor Scott Wade, Swinburne University of Technology

This award recognises the individual who embodies the spirit of collaboration that is integral to DMTC's strategic intent.

Early Career Award

Mr Peter Kabakov, ANSTO and Dr Long Nguyen, DST Group

This award recognises the contribution of early career technical officers, engineers and scientists to DMTC projects, rewarding 'above and beyond' efforts.

Project Leadership Award

Professor Huijun Li for Project 3.11, titled 'Evaluation of keyhole TIG welding on high hardness steels'.

This award recognises excellence in project leadership.

Capability Improvement Award

Awarded to Project 6.1.1.2.1, titled 'Titanium roughing capability'

This award recognises the project team that achieves a significant technical improvement in the area of materials and/or manufacturing technology.

Project Leader: Mr Paul Salerno, BAE Systems Australia

Project team:

- Mr Rob Andrews, Mr Mark Yates, Ms Caroline Chai, Ms Kellie Hussey - BAE Systems Australia
- Dr Suresh Palanisamy, SUT
- Assoc. Prof. Matt Dargusch, UQ

Awards were also presented at the conclusion of the Conference for the best presentation and posters.

Best Poster:

Project 9.09, titled 'Biofouling and corrosion evaluation of HVOF coatings for hydraulic components in marine service'

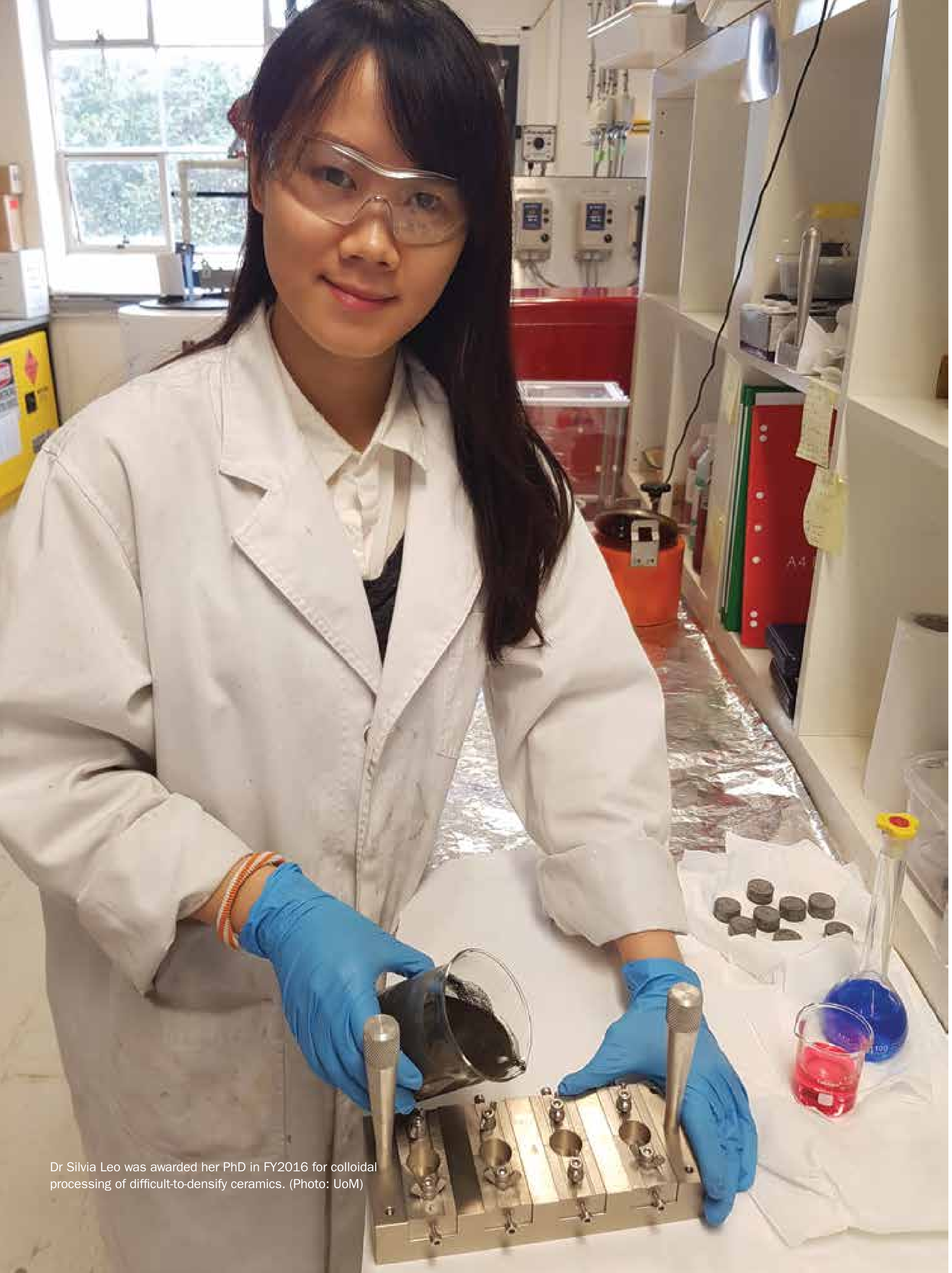
Project Leader, Dr Scott Wade, Assoc. Prof., SUT

Best Student Poster

'Hybrid-mesh ballistic modelling of multi-layer fabric structures' by Mr Eric Yang, UoM

Best Conference Presentation

'Overview of blast modelling in support of occupant safety and platform integrity' by Mr Michael Saleh, ANSTO



Dr Silvia Leo was awarded her PhD in FY2016 for colloidal processing of difficult-to-densify ceramics. (Photo: UoM)

EDUCATION PROGRAM

Over its lifespan, DMTC has made significant investments in developing talent through its Education Program – an investment that has made a real impact, enhancing Defence capability across research and industry sectors. DMTC takes a holistic approach to developing new talent, knowledge and skills. This approach ensures the best and brightest can make meaningful contributions to Defence capability both through their studies and, more importantly, throughout their careers.

Key elements of the DMTC Education Program include:

- an annual Student Conference where sponsored students present their research to peers
- professional development workshops for broader skills development that align with the needs of DMTC industry and research partners
- involvement in project reviews and research utilisation discussions with industry partners
- support to attend conferences.

Since 2008, DMTC has supported more than 40 candidates through scholarships and professional development courses. Postgraduate scholarships are awarded based on alignment with future defence capability requirements and industrial opportunities for Australian industry. To date, 21 DMTC-sponsored PhD candidates have completed their studies and been conferred their PhD.

DMTC has a demonstrated track record of transitioning postgraduates into successful careers within the Defence sector. Students chose a variety of careers across the Defence, research, industry and adjacent sectors, examples include:

- making valuable contributions to developing Defence capability through careers at DST Group and other areas of the Defence organisation
- building defence industry capability through careers with industry partners, typically existing DMTC participants
- continuing their research at various research institutions, typically working on DMTC projects as post-doctoral researchers
- applying skills developed in their PhDs into adjacent industry sectors such as manufacturing, engineering and software development.

DMTC also invests in developing early stage science, technology, engineering and mathematics skills though its established Vacation Student program in which final-year engineering and science students are sponsored to complete 12 weeks of vacation employment with DMTC participants.

Dr Paul Mignone was awarded his PhD in 2016 for the microstructural modelling of metal-matrix composite materials. (Photo: UoM)

DMTC postgraduate scholarships are awarded to those candidates whose research areas align with future defence capability requirements and the corresponding opportunities within defence industry. Sponsored postgraduates are supported through scholarships and professional development courses.

In FY2016 there were 16 active postgraduates involved in DMTC's Education Program, with a further five conferred their PhD.

THOSE STUDENTS WHO WERE CONFERRED THEIR DEGREES IN FY2016

NAME	INSTITUTE	THESIS TITLE	PROGRAM
Dr Long Nguyen	RMIT University	Ballistic performance of UHMW polyethylene armour	Land
Dr Mya Myintzu Hlaing	Swinburne University of Technology	Study of factors influencing bacterial biofilm formation	Sea
Dr Paul Mignone	The University of Melbourne	Modelling two-phase material properties using finite element analysis and microstructure	Air
Dr Silvia Leo	The University of Melbourne	Colloidal processing of difficult-to-densify ceramics	Land
Dr Theo Sinkovits	University of Wollongong	Experimental setup and preliminary investigation of coated tool wear, heat generation and the role of oxygen in face milling of K1045 carbon steel	Air

CURRENT POSTGRADUATE PROJECTS

NAME	INSTITUTE	THESIS TITLE	PROGRAM
Donna Capararo	The University of Queensland	Mechano-chemical rate determining step and mechanisms of crack initiation in aircraft coatings	Air
Eric Yang	The University of Melbourne	Influence of fabric structures on the blast and impact resistance of textile composite materials	Land
Mitchell Sesso	Swinburne University of Technology	Design of thermal barrier coatings for hypersonic applications	Air
Nicholas Orchowski	RMIT University	Investigation into the post-repair performance of Ti6Al4V after the occurrence of foreign object damage	Air
Toby Seidel	RMIT University	Phase compensation methods for load-bearing antenna array	Sea
Vanessa Lussini	Queensland University of Technology	The synthesis and evaluation of novel perylene-based profluorescent nitroxides probes	Air
John Dean	University of Wollongong	Internationalisation of Australian SMEs	
Jimmy Toton	RMIT University	Tool life modelling and machinability characterisation of drilling in titanium alloys produced via conventional and additive manufacturing methods	Air
Brodie McDonald	RMIT University	Characterisation of material effects in blast protection	Land
Kurt Mills	The University of Queensland	Understanding the effect of external fields during solidification of the Al-Mg series alloys	Air
Nathan Edwards	Swinburne University of Technology	Mechanistic failure modelling for high-hardness armour steels	Land
Olexandra Marenych	University of Wollongong	Welding repair technologies for Monel alloy K-500 maritime components	Sea
Cameron McNab	Swinburne University of Technology	Armabot (robotic squad support platform)	Land
Akif Soltan	The University of Queensland	Temporary corrosion protection of new generation magnesium alloys	Air
Panneer Selvam Ponnusamy	Swinburne University of Technology	High strain rate behaviour of metals and alloys processed by additive manufacturing technologies	Air
Riyan Abdul Rahman Rashid	Swinburne University of Technology	Topology optimisation of additive manufactured parts using key materials applied in defence	Air

PhD SNAPSHOT

DR LONG NGUYEN

The ballistic performance of ultra-high molecular weight polyethylene (UHMW-PE) armour

Dr Long Nguyen's research focussed on developing a scientific understanding of the penetration and failure mechanisms of thick UHMW-PE fibre-reinforced composite under ballistic impact. UHMW-PE composite is a promising material for ballistic protection, increasingly replacing aramids such as Kevlar in weight critical applications such as helmets and vests. Its application in vehicles may provide protection against high lethality blast and ballistic threats encountered in theatre while maintaining reasonable vehicle weight. However, the response of UHMW-PE composite to ballistic impact is poorly understood and there are no models that allow such processes to be studied. Dr Nguyen's research characterised the failure process of UHMW-PE composite and developed analytical and numerical models that allow in-situ analysis and ballistic performance predictions.

With DST Group, Dr Nguyen performed several ballistic trials on UHMW-PE composite. Employing state-of-the-art measurement techniques, Dr Nguyen developed a new understanding of the mechanisms of penetration and failure exhibited by UHMW-PE composite under ballistic impact. The penetration process was described mathematically, leading to a new analytical model that describes and accurately predicts the performance of the material against fragment simulating projectiles. A new methodology was developed to accurately simulate UHMW-PE composite using the explicit finite element method. This approach accurately captured the deformation and performance limits of UHMW-PE composite over a wide range of impact velocities, target thicknesses and projectiles. These outcomes have enhanced the understanding of the material performance, enabling the design of better, more optimised armour systems incorporating UHMW-PE composite.

Dr Nguyen currently works as a research scientist at DST Group in the Vehicle Survivability group, where he is continuing his research work on UHMW-PE composite, among other new and emerging armour materials and systems in support of the ADF.

DR SILVIA LEO

Colloidal processing of difficult-to-densify ceramics

Dr Silvia Leo's research focussed on the processing and densification of boride and carbide-based ceramics, in particular zirconium diboride (ZrB_2) and boron carbide (B_4C) for leading edges of hypersonic vehicles and body armour applications. ZrB_2 and B4C are difficult-to-densify materials. As such, it is extremely challenging, if not impossible, to produce complex-shaped and highly dense ZrB_2 and B_4C ceramics using conventional ceramic processing techniques. Therefore, Dr Leo studied an alternative method known as colloidal processing in order to enable the near-net shaping of ZrB_2 and B_4C into complex-shaped powder compacts. This research project also aimed to optimise the ceramic firing conditions of ZrB_2 and B_4C compacts to achieve the desired final properties (high density, small grain size and uniform microstructure).

The colloidal processing method allows for the control of particle-to-particle interaction, minimising the presence of powder aggregates that could lead to defects, poor densification and low strength of the ceramic materials. The findings of this work indicate that powder compacts with a more uniform microstructure and higher packing density were obtained by colloidal processing in comparison with conventional methods. Upon firing under the optimised conditions, the ZrB_2 and B_4C compacts reached almost full density (relative density of 98%) while minimising the occurrence of grain growth within the fired compacts. The ability to near-net shape the objects also eliminated the need for a separate machining step after firing. The development and implication of colloidal processing will deliver a quality improvement (reduced flaws in the final products) and economic benefits to the processing of the materials of interest.

Dr Leo is a development engineer at Morgan Technical Ceramics, where she works on the complex shaping and densification of yttria-stabilised zirconia ceramics. She plans to continue collaborative research with UoM and DMTC.

DR PAUL MIGNONE

Modelling two-phase material properties using finite element analysis and microstructure

Dr Paul Mignone's research focussed on the microstructural modelling of metal-matrix composite materials. Using a combination of micro-computed tomography, image processing and applied finite element analysis, he successfully characterised a copper-infiltrated Tungsten composite for the first time. Using a 3D model of the W-Cu microstructure, Dr Mignone employed finite element analysis to predict its elastic properties and compared this to experimental and theoretical results.

A novel laser ablation system ascertained the 3D microstructural data of W-Cu. Dr Mignone also developed a method of sample preparation for this composite to ensure the correct microstructural information was produced. The mechanical properties produced from simulations using this microstructure were comparable to the physical experimental results. An analytical method of generating microstructures was used to reduce the need to obtain the 3D microstructure using laser ablation systems. The mechanical properties produced from simulations using this microstructure were comparable to the experimental and computational results (with the actual microstructure). The analytical and actual microstructures were used as a foundation to investigate the effects of porosity on the mechanical properties of W-Cu. When porosity was implemented, both microstructures matched the experimental results almost exactly.

Dr Mignone is currently doing postdoctoral research at the Singapore University of Technology and Design. His current areas of focus include soft materials for robotics applications, methods of representing soft materials in design and the mechanical performance of natural composites. Longer term, he aims to focus more on research translation and to work with academia and industry to help reduce the lead time in converting research into valuable commercial outcomes.

FINANCIALS AT A GLANCE - FY2016

The successful execution of a new Commonwealth Agreement to extend Department of Defence funding to 30 June 2018 allowed DMTC to continue to focus on the successful delivery of research outcomes across new and existing program portfolios.

Under the new funding model, DMTC receives a portion of its income from the Defence Industry Policy Division in the Strategic Policy and Intelligence Group*. This is pooled with additional contributions (cash and in-kind) from Australian industry, research agencies and other sources including State Governments.

Revenue for the 2015-16 financial year totalled $24.7 million, which included $11.8 million of in-kind contributions from DMTC's industry and research participants. In-kind contributions from industry and research participants exceeded commitments by 11% for the year. Cash contributions from industry and research participants met their respective commitments for the year. Total revenue included $4.6 million cash funding from CSIRO for the new MCMs program.

Cash on hand at 30 June 2016 totalled $10.1 million, which included $8.3 million of unspent cash funding from the Department of Defence and CSIRO. These funds will be applied to fulfil existing project activity over the term of the Commonwealth Agreement and new research activities under the MCMs Program. Department of Defence funding will also support new strategic research and education program activities, which are of strategic importance to overall defence sector capability in Australia.

formerly in the Defence Materiel Organisation (DMO)

THE YEAR IN SUMMARY	2016 ('000)	2015 ('000)
Revenue (total cash and in-kind)		
Defence customer	6,500	4,500
State Government	15	
Contract revenue	304	
Industry sector and other income	3,358	3,762
Research sector	14,520	7,555
	24,697	**15,817**
Expenditure (total cash and in-kind)		
Capital	32	8
Education	184	207
Projects	17,142	14,732
Administration	2,039	1,887
	19,397	**16,834**
Human resources snapshot		
Full time equivalent staff in-kind contributions	34	39
Postgraduate students	10	29
Centre management employees	8	9
DMTC people directly involved in DMTC activities	**52**	**77**

Testing calibrated weld parts at UoW for an armoured vehicle frame. (Photo: MB)

MANAGEMENT

DR MARK HODGE – CHIEF EXECUTIVE OFFICER

BEng (Hons) and PhD Engineering (Monash)

Dr Mark Hodge has served as Chief Executive Officer of DMTC since its inception in June 2008, overseeing the organisation's success in a range of Defence activities and its transition to a sustainable industry capability partner under the 2016 DIPS. He is a passionate advocate for science and technology in the defence of Australia and its national interests, and has worked in the defence and aerospace fields for his entire professional career.

Dr Hodge is Chair of the City of Latrobe Economic Development Panel, Board Member of the Sir Lawrence Wackett Aerospace Centre (RMIT University) and Advisory Committee Member of the ARC Centre of Excellence for Advanced Framework Materials. He is a former Director and Deputy Chair of the Cooperative Research Centre (CRC) Association. The author of several research publications, Dr Hodge holds four patents on advanced defence materials and is the recipient of several industry and research-sector awards. He is a fellow of The Academy of Technical Science and Engineering.

MR JIM ARTHUR
Chief Operating Officer

MS JANE TISDALL
Financial Controller

ASSOC PROF MATT DARGUSCH
Chief Technology Officer, Enabling Technologies Program Leader

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

JAMES SANDLIN
Program Development Manager, Land (Mounted) Program Leader

DR STEPHEN VAN DUIN
Sea Program Leader

DR SURESH PALANISAMY
Air Program Leader

DR FELICIA PRADERA
Medical Countermeasures Program Leader

MISS BRONWYNNE MCPHERSON
Executive Coordinator

MS ANNE JUPP
Program Support Officer

MR MILES KENYON
Program Development Manager, Education Program Leader

MS CHARLOTTE MORRIS
Supply Chain Engagement, State Government Relations

BOARD OF DIRECTORS

MR TONY QUICK, CHAIR

MA (Cantab)

Mr Tony Quick is independent non-executive Chair of Quickstep Holdings. Mr Quick was the director of the Enterprise Connect Defence Industry Innovation Centre from 2009 to 2011, and director and general manager of GKN Aerospace Engineering Services from 2001 to 2009. Mr Quick is an Adjunct Professor in the School of Aerospace, Mechanical and Manufacturing Engineering at RMIT University.

DR ROGER LOUGH AM, DEPUTY CHAIR

PhD (University of Adelaide) FTSE, GAICD

Dr Lough is an independent consultant specialising in defence technology. He has had a long career as a scientist and research manager at DST Group (formerly DSTO). Dr Lough completed his public service as Chief Defence Scientist and CEO of DST Group between 2003 and 2008. Dr Lough is Chair of the Defence Science Institute Advisory Board. He is a Fellow of the Australian Academy of Technological Sciences (ATSE) and was made a Member of the Order of Australia in 2009. Dr Lough has a PhD from Adelaide University.

DR PETER JONSON, DIRECTOR

BCom, MA (Melbourne), PhD (London School of Economics)

Dr Peter Jonson is Chair Emeritus of the Melbourne Institute, Adjunct Professor at RMIT University and Principal Research Fellow at the University of Melbourne. Dr Jonson is a former director of Village Roadshow and former Chair of Paranta Biosciences, Care CRC, the Australian Institute for Commercialisation, AADI, Bionomics and the Federal Government's CRC Committee. Dr Jonson was interim Chair of the Innovative Manufacturing CRC. Dr Jonson worked for the Reserve Bank of Australia for 17 years as an economist, during which he held the position of head of research for seven years. He was CEO of Norwich Financial Services and managing director and Chair of ANZ Funds Management. He is a Fellow of the Academy of the Social Sciences in Australia.

MRS BRONWYN CONSTANCE, DIRECTOR

FCPA (Australia), FCIS, FAICD

Mrs Bronwyn Constance has held many senior executive positions including finance director of Kraft Foods Australia and New Zealand, vice president Finance of Kraft Foods Asia, executive general manager finance and administration of Pasminco and finance director of Nylex. She spent her early career with the ACI Group of companies. Mrs Constance is a director of the Rail Manufacturing CRC. She is a former independent director of CRC CARE, Colorpak, The Melbourne Market Authority, Plantic Technologies, The Just Group and the CRC for Advanced Automotive Technology. Mrs Constance is Chair of DMTC's Audit, Risk and Remuneration Committee.

MR MICHAEL GROGAN, DIRECTOR

Mr Michael Grogan is a former CEO of Sutton Tools, an engineering manufacturer producing and exporting a full range of cutting tools from three Australian facilities and one New Zealand facility. Mr Grogan was appointed as Victorian director of the Advanced Manufacturing Growth Centre in May 2016. He is Chair of the Inner Northern Local Learning and Employment Network, Board Member of Manufacturing Skills Australia – Industry Skills Council, Board Member of the Adult, Community and Further Education organisation and Member of the Victorian Manufacturing Skills and Training Taskforce. Mr Grogan is a member of DMTC's Audit, Risk and Remuneration Committee.

PROFESSOR JOHN NORRISH, DIRECTOR

Eur Ing. C eng Msc. Fweldl. FIIW.

Professor John Norrish is an Emeritus Professor at the University of Wollongong. Holding a Bachelor of Science in Metallurgy and Masters of Science in Welding Technology, Professor Norrish has more than 200 publications in refereed journals and international conferences and has received numerous awards. These include the International Institute of Welding E.O. Paton Prize for 'a lifetime of contribution to welding technology' and an honorary 'Fellow of IIW' in 2016 in recognition of his distinguished contributions to welding science and technology. He is author of 'Advanced Welding Processes', last re-published in 2006. He is a director of the Welded Structures Foundation, member of the steering committee of ITTC Research Centre for Naval Design and Manufacture and vice Chair of the International Institute of Welding Commission XII. Professor Norrish is Chair of DMTC's Research Advisory Panel.

DR JOHN BEST, DIRECTOR

PhD (University of Wollongong), Bsc (Hons) (University of Queensland), MBA (University of Adelaide), GAICD

Dr John Best currently holds the position of vice president strategy & technical at Thales Australia. Dr Best joined ADI in 2003 and was appointed as Chief Technology Officer upon the formation of Thales Australia in 2006. In this role he was responsible for the technical capability of the company, including technical strategy, research and development, innovation, engineering process and engineering development. In 2013, he additionally assumed responsibility for strategy within the company. The move to ADI followed a 15-year career with DST Group. Dr Best is a director of Eurotorp and member of DMTC's Audit, Risk and Remuneration Committee.

CONTINUOUS IMPROVEMENT

It has been another very successful year for DMTC's Continuous Improvement Program. DMTC commenced this program through participation in the Defence Industry Innovation Centre's Supplier Continuous Improvement Program (SCIP) in 2012. SCIP focuses on embedding best practice leadership and continuous improvement through benchmarked performance measures.

DMTC is proud to report that its Business Excellence score in the most recent annual self-assessment is the highest recorded in the SCIP program to date. This is a huge achievement by the team and demonstrates the gains the company has made through this program. As a result of the culture change at DMTC, improvements in organisational performance and efficiency are now embedded in 'how we do business'. Aside from the improved business efficiencies derived from DMTC's participation in the SCIP program, these efficiencies have freed up resources that can be invested in program activities to the direct benefit of our partner organisations.

DMTC continues to drive efficiencies in its systems and operations with a focus on stakeholder satisfaction and Defence-focussed outcomes. The past 12 months have seen a step change in focus and impact to how DMTC conducts business. This step change has come through implementing sophisticated data collection and analysis relevant to how DMTC does business so that metrics and trends are available for evidence-based decision making on the performance of projects and to ensure they are conducted in a manner that maximises value for participants.

Examples include:

- detailed health monitoring dashboards at a project, program and corporate level that incorporate performance against budget, milestone achievement and team function
- detailed analysis of the resources required to progress technologies through the technology readiness level scale
- business process mapping exercises to identify information flow, quality standards and lead and wait times of key operational processes and where efficiencies can be achieved
- assessment of lessons learned in the program definition phase of establishing new DMTC programs leading to improved project and program solicitation processes.

The next phase of the DMTC continuous improvement journey will focus on the implementation of an ISO 9001:2015 accredited quality management system. Achieving this accreditation will provide DMTC with a formal, internationally recognised framework through which to monitor and manage quality across its systems and processes, ensuring a customer focus. It will align with and complement our existing continuous improvement activities.

DMTC would like to thank the SCIP program facilitators for their continued guidance on continuous improvement principles.

UoW's Mr Nathan Larkin tests calibrated weld parts for an armoured vehicle. (Photo: MB)

GOVERNANCE

The DMTC Board is responsible for overseeing the management and strategic direction of the Company. Each Director is generally elected for a two-year term by the Company's Members at the AGM. In accordance with the company constitution, the Directors have a comprehensive collective range of skills and experience within the defence industry and in systems, policies, research, financial and risk management and corporate governance.

ANNUAL GENERAL MEETING AND PARTICIPANT WORKSHOP

The DMTC Participant Workshop was held on 5 November 2015. The workshop provided participants with an update on the Company's new program activities, future contract discussions with the Commonwealth, future research activities and remaining activities under the existing Personnel Survivability program.

The DMTC AGM was also held on 5 November, immediately after the participant workshop. Members of DMTC provided unanimous endorsement of DMTC's Strategic Plan as well as new and existing and future planned research activities. Directors Mr Tony Quick, Dr John Best and Professor John Norrish retired at the meeting in accordance with constitutional requirements 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 non-executive Directors of DMTC, the majority of whom are independent.

RESEARCH ADVISORY PANEL

The Research Advisory Panel has provided advice to the CEO on technical research areas including:

- suggested areas of technology focus
- possible linkages across research expertise
- ensuring research undertaken is of world-class standing.

DEFENCE ADVISORY PANEL

The Defence Advisory Panel has provided advice to the CEO in relation to Defence program structures and priorities to ensure DMTC's current and future planned activities address the priority technical concerns of Defence. The panel's role is being reviewed, including terms of reference and membership, in the context of the evolved Defence innovation system.

A laser metal deposition machine in RMIT's advanced manufacturing precinct used in the repair of components. Laser cladding technology offers more versatility than the cast metal process in terms of design revision. (Photo: MB)

GLOSSARY

ADF	Australian Defence Force
AGM	annual general meeting
AiG	Australian Industry Group
AM	additive manufacturing
ANSTO	Australian Nuclear Science and Technology Organisation
AOLP	automated off-line programming
BW	bio-warfare
CAE	computer-aided engineering
CBR	chemical, biological and radiological
CRC	Cooperative Research Centre
CSIRO	Commonwealth Scientific and Industrial Research Organisation
D4	double diaphragm deep drawing
Defence	Australian Defence Organisation
DIPS	Defence Industry Policy Statement
DISP	Defence Industry Security Program
DMD	direct metal deposition
DMTC	Defence Materials Technology Centre
DST	Defence Science and Technology
DWP	Defence White Paper
FY	financial year
GFRP	glass fibre-reinforced polymer
HVOF	high velocity oxygen fuel
L-RTM	light resin transfer moulding
LCT	laser cladding technology
LOTE	life-of-type extension
MCMs	Medical Countermeasures
Mip	macrophage infectivity potentiator
PFC	personal fuel cell
PhD	Doctor of Philosophy
POC	point-of-care
PZT	lead zirconate titanate
QUT	Queensland University of Technology
R&D	research and development
RMIT	Royal Melbourne Institute of Technology
RTM	resin transfer moulding
SCIP	Supplier Continuous Improvement Program
SLM	selective laser melting
SME	small to medium-sized enterprise
SPD	supersonic particle deposition
SP&I	Strategic Policy and Intelligence
SSBA	security sensitive biological agents
SUT	Swinburne University of Technology
T-GMAW	gas metal arc welding
Thales	Thales Australia
TRL	Technology Readiness Level
TUS	Thales Underwater Systems Australia
UoM	The University of Melbourne
UoW	The University of Wollongong
UQ	University of Queensland
VARTM	vacuum-assisted resin transfer moulding

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