CREATING FUTURE CAPABILITY

2015 DMTC ANNUAL REPORT

DMTC DEFENCE MATERIALS TECHNOLOGY CENTRE

Pilot Al Norman, the F-35 Chief Test Pilot, flying Australia's first F-35. (Photo: Department of Defence)

MINISTERIAL FOREWORD

Delivering Australia's future defence capability will require a strong partnership between government and industry. The Turnbull Government strongly supports maximising the opportunities for Australian industries to participate in defence acquisition and sustainment.

In a global environment where the pace of technological change is rapid, innovative ideas and solutions are necessary to achieve the capability outcomes for our Defence Force. Collaboration between industry and the research sector is critical to translate those solutions into internationally-competitive defence capability.

The Defence Materials Technology Centre (DMTC) creates a dynamic and effective collaborative environment for Australia's defence industry, research sector and government agencies to work together to develop new materials and manufacturing technologies that will enhance Australia's defence capability.

The Centre's collaborative research program is aligned with defence science and technology priorities and ensures the work undertaken between Australia's industrial and research sectors addresses key defence challenges and drives capability outcomes.

Adaptability and innovation must continue to be the hallmarks of our Australian defence industry.

I welcome the 2015 DMTC Annual Report and congratulate the Centre on its achievements over the past 12 months.

THE HON MAL BROUGH MP
Special Minister for State
Minister for Defence Materiel and Science

STRENGTHENING DEFENCE INDUSTRY

With the tempo of Defence acquisitions planned to increase significantly in coming years, the opportunities for Australian industry will be significant indeed. In order to best support Defence capability and remain globally competitive, the defence industry has been challenged to maintain its edge as an innovative, flexible and responsive fourth arm of our nation's security umbrella in support of the Australian Defence Force (ADF).

The Australian Industry Group (AiG) Defence Council is the principal voice for our defence industry. The Council has been a strong advocate for the work of the DMTC and will continue to help position Australian industry to maintain its support for the ADF, in keeping with our three main goals:

— Recognition of Australian defence industry's major role in helping meet Australia's national security objectives, supplying equipment and support to Australian Defence.

— Ensuring that the knowledge, technology and innovation of Australian defence companies, including SMEs, is formally recognised by all levels of government and the wider community.

— Continuing to foster the skills and expertise of Australian defence industry, including for priority industry capabilities and as a source of critical support to the ADF in meeting its many operational responsibilities.

DMTC has proven itself to be a critical enabler of each of these key objectives. Its track record in supporting Australian defence industry capability is second to none across each of the air, land and sea domains.

The AiG Defence Council was delighted therefore, to learn that DMTC had been recontracted and will continue to work closely with Tony and Mark to align current and future endeavours to continue support to Defence, and to defence industry and supply chains.

The Council regards DMTC as an important tool for the nation and we look forward to future success.

CHRIS JENKINS
CHAIR
AIG DEFENCE COUNCIL

A controlled detonation of an Improvised Explosive Devise (IED) explodes in front of an Australian Bushmaster during a move down one of the most dangerous IED routes in Northern Kandahar. (Photo: SGT Neil Ruskin)

HMAS Canberra docked down in Jervis Bay during work ups in preparation for Unit Readiness Evaluation. (Photo: LSIS Helen Frank)

THE INNOVATION AGENDA

Strategic investments in science and technology underpin the ADF's capability edge. Science and technology must therefore be at the forefront of innovation to support a defence force that is agile, effective and has superior capabilities.

For some years now, the Defence Science and Technology (DST) Group has been pursuing a program of external engagement through strategic partnerships and close collaboration with industry, research agencies and universities. It is increasingly through our collaborative partnerships that we are able to deliver innovative capability outcomes for the ADF.

DMTC is a key Defence partner, providing DST Group a vital interface to cutting-edge research capabilities in Australian industry and universities. DST Group and DMTC have an outstanding track record of success in collaborating on defence science solutions across the sea, land and air domains.

Our range of collaborative work is demonstrated in areas such as body armour, blast modelling and explosive bonding of materials. We have also extensively worked together on corrosion prognostics and microbiologically influenced corrosion (MIC) and manufacturing technology for the maritime sector, including sonar materials and maritime steels.

The significant impact on Defence capability of DMTC-DST Group collaboration has resulted in a commitment to future projects under an extended contract.

DMTC is being recognised for its excellent contributions to Defence, winning the 2015 Cooperative Research Centre (CRC) Award for Excellence in Innovation. This award is well deserved, recognising DMTC work on boron carbide ceramic armour technology, which provides the ADF with increased ballistic protection.

It was pleasing to see the DMTC-sponsored PhD candidate, Vanessa Lussini from Queensland University of Technology (QUT), being awarded the Aerospace Australia Ltd Young Innovator Prize – presented at the Avalon Airshow earlier this year. During Pacific 2015, DMTC was awarded the Maritime Australia National Defence Innovation Award for developing tandem gas metal arc welding to improve naval manufacturing processes.

I was particularly pleased with this award as it recognised the collaborative work of DMTC with DST Group, Forgacs Engineering, University of Wollongong (UoW) and ANSTO. This is the fourth time in recent years that significant innovation awards have been won by DMTC researchers at major Defence industry events.

A strong commitment to fostering the talent of the future will keep both Australia's Defence Science capabilities in good stead as together we continue to find innovative solutions to deliver the best capabilities for the ADF.

The Australian government has re-energised its focus on innovation as a means of invigorating our national economy. The DMTC has an important role to play in taking the government's innovation agenda forward.

DR ALEX ZELINSKY
CHIEF DEFENCE SCIENTIST

Members of the ship's company line the flight deck of HMAS Canberra (Photo: LSIS Helen Frank, ADF)

CONTENTS

Front cover image: Gun crews load the 25mm Typhoon onboard HMAS Canberra during Unit Readiness workup (POIS Ollie Garside, ADF)

Design and art direction by JAC&
Commissioned photography by Mike Baker
Publication management by Jasmine Smith

HIGHLIGHTS FY 2015

5 PROGRAMS across AIR LAND and SEA domains

399 PEOPLE
directly involved in DMTC activities

28 PARTICIPANTS
working together for a more SECURE future

PROVEN COLLABORATIVE MODEL

$9.8m
annual in-kind contributions

41 PROJECTS
delivering new technologies and manufacturing processes

$16.8m ANNUAL EXPENDITURE
on improving the capabilities of Australia's defence sector

CHAIR'S REPORT

TONY QUICK,
CHAIR
DMTC LTD

We are delighted to present DMTC's 2015 Annual Report Highlights. The future is bright indeed for DMTC as we embark on a range of new technology development activities in support of industrial capability outcomes in the air, land and sea domains, with a number of additional opportunities in prospect.

Looking forward as we finalise our foundation contract, I am proud to note that DMTC research continues to be recognised by a range of prestigious organisations through awards for the excellence of its science, its ability to transfer its technology into industrial capability and its impact on Defence capability.

Significantly, DMTC has also received recognition for its business processes in the context of a continuous improvement approach to program management. The Board and management team have focused on achieving this balance between technical, commercial and capability outcomes and this will, of course, continue into our future activities.

The recontracting of DMTC has been a significant milestone in the evolution of Defence industry capability development in Australia, validating as it does, the business model and track record of the centre, but also incorporating important new business model features that bring a closer engagement with the Defence customer through program concept development and throughout the program delivery phase. Our work, underpinned by Australia's best science, technology and engineering skills by collaboration through DMTC has been a resounding success.

No organisation is guaranteed a future and DMTC is of course no different. While so many in our sector are invested in our success, our role is to make a positive difference to each of these groups and our success and future prospects will be measured to a large degree in these simple terms. In this context, our challenge is to continue to foster productive and proactive relationships with new development and support programs in a rapidly changing Defence environment. I am confident that this will occur as Mark and the management team continue to ensure they remain operationally responsive to the variety of drivers and conditions in which we operate. I'm delighted that the DMTC model has been so successful to date and would like to pay particular tribute to the many who have played such a significant role in the strategic, operational and financial support of our organisation over the past several years.

CEO'S REPORT

MARK HODGE,
CEO
DMTC LTD

When DMTC was established in 2008, we created an organisation with active research programs and robust governance and management principles from a standing start. In the seven years since, we have enjoyed superb relationships with our Defence, industry and research partners, which have yielded some quite significant results.

DMTC's ability to effectively deliver on its charter and successfully secure new collaborative contract opportunities has its origins in open, frank and transparent relationships with our stakeholder groups, a shared sense of purpose in the manner and direction in which we conduct our technology development activities and mutual trust between all parties. I believe the value generated for Defence is well understood by senior Defence and military personnel. The support of the Capability, Acquisition and Sustainment Group (CASG) and DST Group in Defence is a particularly important and determining factor in our past and future success.

I am proud of the effort and continued commitment shown by the DMTC community in this regard – everyone I speak with is clear on the need to continually evolve and improve our service and the manner in which it is delivered. With this commitment as a backdrop to our future activities, I remain very confident of our future.

I take this opportunity to thank the participant group, Board of Directors and management team for superb continued commitment, not just in the past year, but throughout the past seven years since the organisation was founded. I would also like to make particular mention of the leadership in Defence, which has provided us with the operational context and active support through which we can drive industrial capability development outcomes.

I can scarcely imagine a more committed group and have great pleasure in presenting the 2015 Annual Report Highlights.

ABOUT DMTC

VISION

To provide technology solutions enabling industry to enhance Australian Defence capability

MISSION

DMTC will lead, facilitate and manage cooperative research in the defence sector in materials, manufacturing and related themes with the Defence customer, industry and research sector as key stakeholders

STRATEGIC INTENT

Capability through collaboration

With a proven model for Defence innovation in a multi-stakeholder environment, DMTC brings together participants from Defence, industry and research institutions to collaborate on projects that advance Australia's military capability across the air, land and sea domains.

Over the past seven years, DMTC has refined its model to ensure all stakeholders remain optimally engaged and communicate effectively within carefully defined projects at the cutting edge of manufacturing and materials technology. With the critical support of its stakeholder organisations, DMTC has developed a best-practice program management model that maximises stakeholder value and delivers outcomes across its three main stakeholder groups of Defence, industry and the research sector. This program management capability has led to additional programs outside the traditional materials and manufacturing technologies, now being brought in under DMTC's program structures.

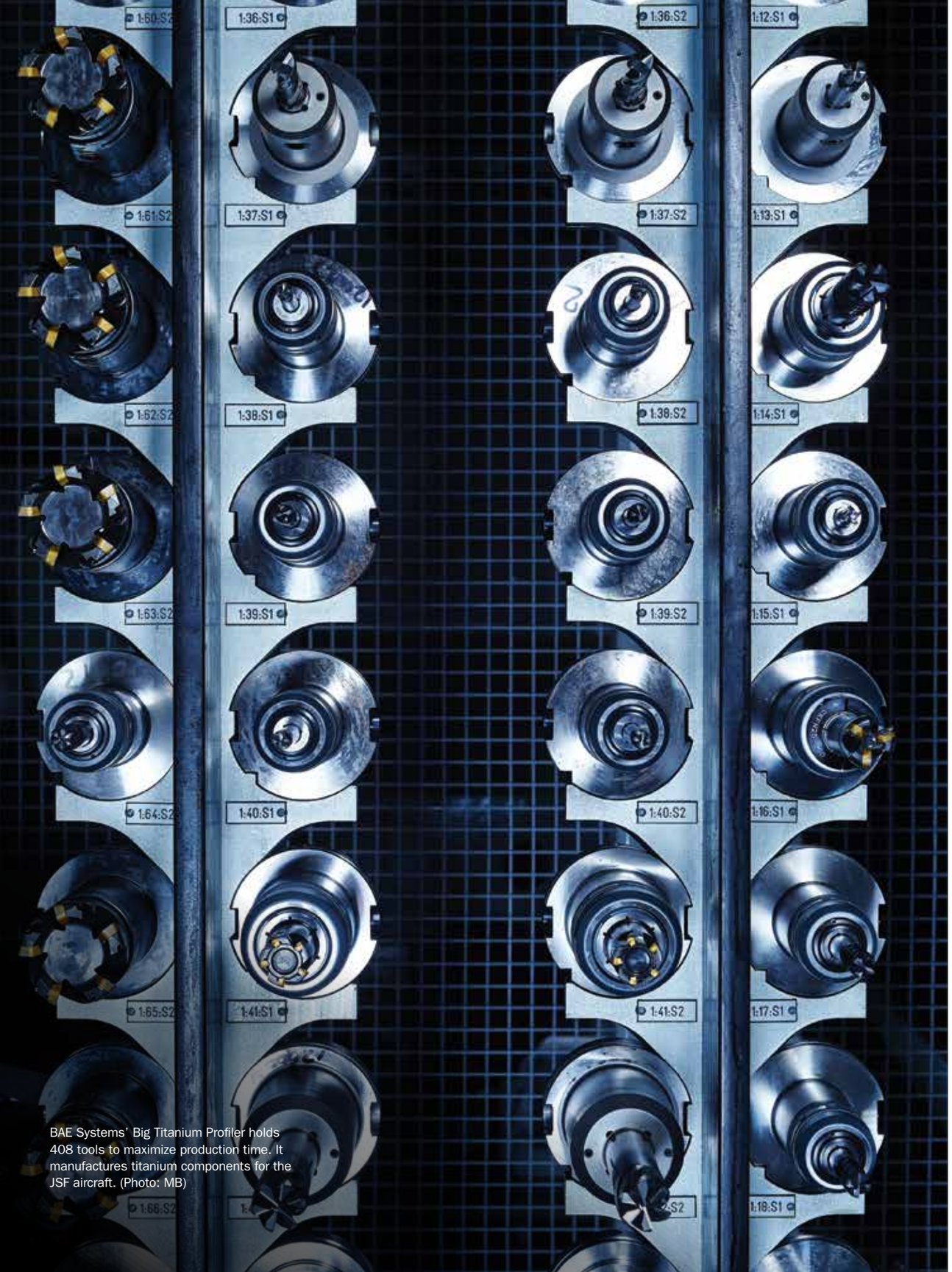
Crucially, DMTC's projects are framed around real capability challenges identified and articulated to us as priorities by Australian Defence and other Commonwealth agencies. In meeting these challenges, project teams progress through a process of conception, management and finally, delivery of the technology to industrial partners. Defence is then able to access capability improvements through the normal procurement channels.

DMTC's best-practice approach continues to deliver outstanding achievements in research excellence, commercialisation of technology and continuous improvement of business processes. These results are of course a testament to excellence in capability and cutting edge science, engineering and technology in our partner organisations, through which the technology is developed and delivered.

Along the way, Australian SMEs, as well as larger industry participants, can realise many benefits - a competitive edge, access to global supply chain opportunities, increased productivity, optimisation of manufacturing and production processes and low-cost access to R&D.

Research participants benefit from the ability to conduct contextualised research in a multi-disciplinary, cross institutional program. Research personnel gain professional development in the form of workshops and an annual conference, access to state-of-the-art equipment, invaluable networking and career opportunities, and the chance to see their concepts progress to the commercialisation stage.

Paul Salerno, Senior Production Engineer at BAE Systems, inspects a titanium component in a Coordinate Measuring Machine. (Photo: MB)



BAE Systems' Big Titanium Profiler holds 408 tools to maximize production time. It manufactures titanium components for the JSF aircraft. (Photo: MB)

CREATING FUTURE CAPABILITY

One of the key challenges for the defence sector is to align the capabilities of a broad stakeholder group, including prime contractors, supply chain participants and the research sector, to deliver a capability outcome for Defence end-users and practitioners that is cost effective and best of breed. DMTC's business model not only allows, but relies on the active participation of each stakeholder group, ensuring dynamic interaction between Australia's highly skilled industrial sector and the range of research, development and innovation organisations, with activities conducted in the context of close interaction with Defence's procurement group CASG and innovation integrator, DST Group.

DMTC's program management model is now being used to extend beyond the traditional areas of materials and manufacturing technology, to other technology sectors. The first of these is in the area of Medical Countermeasures. It has commenced with technical leadership from CSIRO and DST Group overlaid across DMTC's program management structures and is a template for future cross-sectoral activities.

DMTC's role is to develop industrial capability underpinned by high quality science and engineering R&D that can be made available to the Defence customer through the normal procurement channels. DMTC programs can mitigate procurement risk to Defence by providing guidance to industry on likely future capability requirements without compromise to the principles of best-value capability for the taxpayer, as DMTC programs are conducted in a pre-competitive environment. Industry benefits are derived from increased competitive advantage, and optimised cost-effectiveness while the research sector gains a more mature understanding of the particular demands and features of technology development unique to the Australian defence sector.

DMTC is fortunate to have a highly capable participant group through which research capability is sourced and capability delivery to Defence occurs. Through our interactions with a range of Australian Defence Organisation agencies, most notably CASG and DST Group, these participant organisations are able to focus their development efforts in a cohesive manner, each leveraging the financial and technical capabilities of the other. The result is improved cost-effectiveness and accelerated capability development for Australia's defence needs.

DMTC programs in the shipbuilding arena focus on a range of manufacturing technologies aimed at benchmarking and improving shipbuilding productivity and capability, to ready the Australian supply chain for the increased shipbuilding tempo in future years.

DMTC research in the land vehicles space has improved Australian industry's ability to design, develop, build and test protected mobility vehicles in current and future platforms

Corrosion detection, mitigation, remediation and repair capabilities will remain paramount across a range of Defence platforms. Working with DST Group, DMTC activities provide a structure for benchmarking and delivering a range of these and other sustainment capabilities to Defence.

DMTC-sponsored PhD candidate Vanessa Lussini (QUT). (Photo: Erica Fish)

RECOGNITION AND AWARDS

DMTC was awarded the **CRC Association Award for Excellence in Innovation 2015** for its work on boron carbide ceramic armour technology. A key component of the award criteria was research and industry collaboration. DMTC was ideally positioned to bring together Defence, academic and industry stakeholders essential to this project. The team reflected the benefits of multiparty collaboration, with each partner contributing unique but critical elements required to achieve the outcome. As a consequence of this work, the ADF now has the capability to incorporate the high ballistic resistance of boron carbide into complex components previously thought to be only suitable for manufacture from alternative materials which do not offer the same degree of ballistic protection for a given weight, such as tailoring for specific body shapes, including for frontline female combatants.

At the Avalon Airshow, DMTC was awarded the **Aerospace Australia Ltd Defence Industry SME Innovation Grant** for work in developing and upskilling the supply chain to support BAE Systems' manufacture of vertical tail components for the Joint Strike Fighter (JSF). The activity involved close collaboration between a number of supply chain companies and research organisations, including BAE Systems, Sutton Tools, Vipac Engineers & Scientists Ltd (Vipac), Seco Tools, Swinburne University of Technology (SUT), The University of Melbourne (UoM), RMIT University and The University of Queensland (UQ), and resulted in the development of a range of capabilities supporting improved productivity and greater cost competitiveness in the manufacture of military aerospace components.

DMTC-sponsored PhD candidate Ms Vanessa Lussini of QUT was presented the **Aerospace Australia Young Innovator Prize** at the Avalon Airshow. The award recognises individuals who are leaders in aerospace and aviation technologies and innovation. Vanessa's project developed new sensor molecules that can monitor the breakdown of aircraft coatings. They enable a sensitive, real-time monitoring technology within the coating to show the location and extent of the coating's wear.

DMTC was awarded the **Land Defence Australia National Industry Innovation Award**. This award was presented at the Land Forces Conference 2014 and recognised the work on boron carbide body armour production undertaken by DMTC led project consortium of Australian Defence Apparel (ADA), CSIRO, Victorian Centre for Advanced Materials Manufacturing (VCAMM), DSTO, UoM and SUT.

DMTC research engineer, Mr Tristan Alexander of Deakin University, was awarded the **Land Defence Australia Young Innovator Scholarship**. This award was presented at the Land Forces Conference 2014 and recognises individuals who are leaders in technology and innovation in the land domain. Tristan was presented the award as a result of his work in polymer ceramics. Key advances include the development of new tooling and quasi-static test methods improving yields and development time. DMTC researchers have now won the Young Innovator prize at the past three major Defence Platform shows – Pacific 2013, Land Forces 2014 and the 2015 Avalon Air Show.

DMTC's PhD student, Mr Long Nguyen of RMIT University, was awarded the **Best Poster Presentation** by the panel representing the South African Ballistics Organisation (SABO) at the 28th International Symposium on Ballistics (ISB) held in Atlanta, Georgia, USA. The ISB is one of the premier global conferences on ballistics. There were more than 160 posters presented and the recognition of Long's work is also a recognition of the quality and world leading science and engineering taking place within DMTC collaborations.

SUT and DMTC-sponsored PhD student Mr Muhammad Awais Javed won 1st place in the **Annual Brian Cherry Award** Forum held by the Victorian Branch of Australian Corrosion Association at SUT for his presentation entitled 'Acceleration or inhibition in microbiologically influenced corrosion (MIC)? It's your call'.

DMTC ANNUAL CONFERENCE 2015

The DMTC Annual Conference was held in Canberra on 17 and 18 March 2015. The format incorporated a combination of technical presentations, panel discussions and guest speakers from industry and Defence. Feedback solicited by DMTC from attendees indicated the program on both days was extremely well received and highly valued.

KEYNOTE SPEAKERS

- Dr Alex Zelinsky, Chief Defence Scientist, DSTO
- Ms Michelle Kelly, Head, Defence Industry Division, DMO
- Air Vice Marshal Mel Hupfeld, Head, Capability Systems, Capability Development Group (CDG)
- Air Vice Marshal Leigh Gordon, Head, Aerospace Systems Division, DMO
- COL Mark Jennings, Director, Diggerworks
- Mr Rob Milligan Maritime Acquisition, DPM, LHD Project, DMO

PRESENTATIONS

- Ms Claire Willette, Director, Strengthened Export Controls
- Dr Stephen van Duin, Program Leader, DMTC
- Mr Nathan Larkin, UoW
- Dr Scott Wade, SUT
- Mr James Alexander and Mr Christopher Dean, ANSTO/Thales Australia
- Mr Nathan Lane, UoW
- Dr Matt Dargusch, Program Leader DMTC
- Mr Simon Jacob, BAE Systems
- Dr Suresh Palanisamy, SUT
- Mr Paul Salerno, BAE Systems
- Mr Nicholas Orchowski, RUAG Australia
- Dr Dinesh Shanmugam, Thales Australia
- Mr Huon Bornstein, DSTO
- Mr Michael Clark, Thales Australia
- Dr Ian Crouch, Armour Solutions
- Mr Deepak Ganga and Mr James Sandlin, Program Leaders DMTC

DMTC AWARDS FOR EXCELLENCE

At the DMTC Annual Conference Dinner the Awards for Excellence were presented. These awards recognise individuals and project teams whose efforts have significantly contributed to the execution of DMTC's vision and mission. Those awarded were as follows:

AWARD	RECIPIENT
Industry Partnership Award	Horace Billon of DSTO and Tony Pierlot of CSIRO
Early Career Award	Vanessa Lussini of QUT
Capability Improvement Award	Project 3.8 for its work on 'Alternative materials and manufacturing for next generation armoured vehicles'
Research Collaboration Award	Neil Matthews of RUAG Australia (formerly Rosebank Engineering)
Project Leadership Award	Scott Wade of SUT for Project 2.5 'Microbiologically influenced corrosion'

At the end of the DMTC conference, awards for best presentation and poster were made. The recipients of these awards were:

- Best Conference Presentation Award – Huon Bornstein, DSTO
- Best Project Poster – Project 3.4 - Comparison of Mechanical and Welded Joints for Construction of Components for Armoured Vehicles
- Best Student Poster – Stephen Sun, PhD candidate RMIT University.

Industry participant Sutton Tools is involved in DMTC's new tooling capability development project. (Photo: MB)

CONTINUOUS IMPROVEMENT

DMTC began participating in the Defence Industry Innovation Centre's (DIIC) Supplier Continuous Improvement Program (SCIP) in 2012. SCIP is a three-phase change program that focuses on embedding best-practice leadership and continuous improvement and provides benchmarked performance measures and an improvement plan.

Continuous Improvement (CI) within DMTC ensures that projects are conducted, and will continue to be conducted, in a manner that maximises value for participants. The program aligns with DMTC's goals and objectives, and allows for the efficient and effective implementation of DMTC's strategic plan, while continuing to provide efficient value-adding services to our participants, Defence and Government.

In the final phase of the SCIP, DMTC's CI program continued to go from strength to strength. Following the significant improvement from our first to second cycle assessment, DMTC set ambitious goals for the program. Diagnostic results indicate excellent performance in Business Excellence with above average Office Excellence performance.

DMTC's efforts were acknowledged by the DIIC, AIDN and the AiG Defence Council, who presented DMTC with the 'Most Improved' award at the D+I Conference in 2014. The award was bestowed for demonstrating the most improvement between cycles in diagnostics scores for Business and Office Excellence.

DMTC would like to thank Enterprise Connect and in particular, the DIIC facilitators, who have worked with DMTC over several years. Their expertise and guidance in implementing CI Programs has been invaluable and has ultimately led to the success of our program.

Having completed the full program, DMTC will continue to incorporate continuous improvement objectives as part of its normal business processes.

PARTICIPANTS

DMTC is comprised of participant organisations who all contribute resources towards the research and development activities.

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

DMTC's collaborative model:

— fosters enduring collaborative relationships between major manufactures, SMEs, research organisations, industry bodies and Defence

— features an IP model focused on rapid royalty-free transfer to participant organisations

— simplifies the formalisation of collaboration with standardised agreements

RESEARCH

ANSTO

CAST

The University Of Queensland AUSTRALIA

RMIT UNIVERSITY

VCAMM accelerating innovation

University of Wollongong AUSTRALIA

Australian Government
Department of Defence
Defence Science and Technology Group

CSIRO

QUT

The University of Melbourne

Swinburne University of Technology

INDUSTRY

BlueScope

suttontools world class cutting tools

Bruck textiles

Forgacs

SECO

ADA

Ventou Garment Technology

BMT Ballistic & Mechanical Testing

Bisalloy Steels

Together ahead. RUAG

ViPAC Engineers & Scientists

Henkel

THALES

Apoca Engineering Pty Ltd Quality and Service

BAE SYSTEMS

Australian Industry & Defence Network AIDN

Soldiers from 2nd Battalion, Royal Australian Regiment, embark HMAS Canberra in Townsville to conduct amphibious training. (Photo: Department of Defence)

PROGRAMS

DMTC currently operates five technology development programs across the air, land and sea domains. DMTC projects have historically focused 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 medical countermeasures against chemical or biological threats.

Current areas in which DMTC facilitates projects include:

Manufacturing – Fabrication

— Machining
— Tooling
— Additive manufacturing
— Bonding and joining
— Welding
— Casting
— Automation
— Design for light weighting
— Modelling and simulation

Materials – Sustainment

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

Materials – Advanced

— Metals
— Composites
— High temperature
— Modelling and simulation
— Armour
— Steels
— Textiles
— Ceramics
— Piezoelectric crystals
— Power and energy

SEA

The largest ship ever built for the Royal Australian Navy, Landing Helicopter Dock NUSHIP Adelaide, passes through Sydney Heads for the first time. (Photo: ABIS Kayla Hayes)

IMPROVING PRODUCTIVITY AND ENHANCING SUSTAINMENT PRACTICES OF THE AUSTRALIAN MARITIME INDUSTRY

PROGRAM LEADER

DR STEPHEN VAN DUIN

Australia is embarking on the biggest naval acquisition program in its history, providing Defence with the opportunity to create a modern, capable fleet never seen before.

In order to ensure the most operationally capable vessels, the materials and manufacturing technologies used to construct each ship need to be world class.

DMTC is working with industry, research and Defence to provide technologies that will give our Navy a leading edge in operation, manufacturing and sustainment.

SEA DOMAIN OVERVIEW

DMTC's Maritime program can be broadly separated into new materials, material performance and manufacturing efficiency. Whether Australia relies on its in-country supply chains for new acquisitions or integrates foreign systems, the unique operating conditions of our Navy requires technologies designed specifically for our fleet.

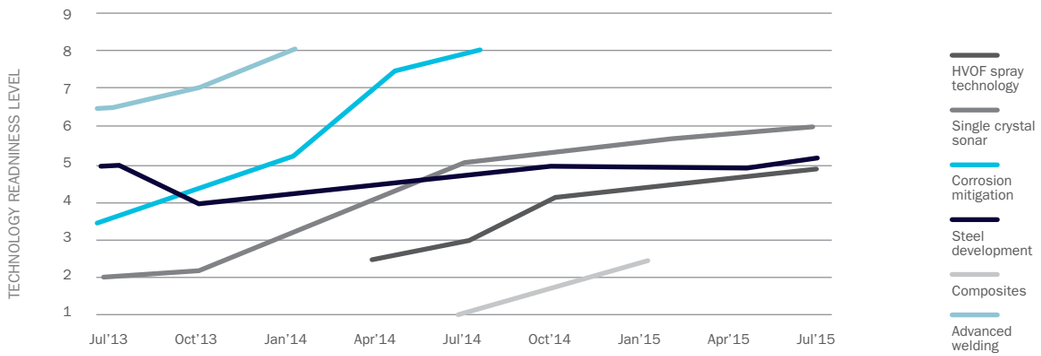
Since DMTC'S inception, the Maritime program has developed more than eight technology packages, ranging from the development of high-strength steels, multifunctional composite structures and corrosion-resistant coatings, to the development of manufacturing technologies for advanced sonar, advanced welding and joining, wear-resistant spray technologies and ship building automation. In the area of sustainment technologies, advances in surface treatment of critical underwater components, evaluating microbiologically induced corrosion and corrosion resistant coatings have all contributed to management practices for fleet availability.

Technologies developed in DMTC's Maritime program have supported considerable improvements in Australian shipbuilding productivity and capability. Ongoing research and development will see the adoption of the remaining technologies increase with time. Research in this program has generated more than 60 publications in addition to 25 comprehensive technical Milestone reports.

Building on existing strengths, DMTC's Maritime program will continue to progress current technologies while exploring new opportunities specific to Australian Defence's Future Frigate Program (SEA 5000). The following four project technology areas are at the core of DMTC's developed expertise and will form the platform for future expansion of the Maritime program:

- Further development of advanced sonar using state-of-the-art single crystal transducers
- Development of advanced welding and joining to modernise our ship building industry
- Increased understanding of corrosion and sustainment requirements
- Use of analytical modelling to determine ship life-of-type and life extension

CAPABILITY DEVELOPMENT TRAJECTORY



Dr Gerry Triani of ANSTO works on single crystal piezoelectric materials to improve sonar equipment. (Photo: MB)

Dr Linggen Kong of ANSTO sintering ceramic piezoelectric samples (Photo: MB)

DAMPING STRUCTURAL COMPOSITES FOR NAVAL STEALTH

Due to their superior strength to weight ratio, composites are more frequently being employed in high-performance, structurally critical applications. Damping performance (vibration reduction) of composite structures has traditionally been overlooked, with the focus primarily being on mechanical performance. As the design envelope for composites is expanded into maritime platforms, damping will play a more crucial role in material selection and component design. Vibration is usually undesirable in structural applications. Propagation of damage can lead to structural weakness and ultimately, early failure of a material. Furthermore, vibration leads to acoustic emissions that may compromise strategic operations in maritime applications. Increased structural damping has the potential to mitigate the effects of vibration and increase the performance and life of a component.

Researchers at RMIT University, DST Group and CSIRO have investigated the feasibility of utilising hybrid composites to improve structural damping performance. Two methods of hybridisation were explored. The first involved interleave layers of NL 25 cork agglomerate and Dyad 606 embedded at the laminate mid-plane as a constrained damping layer. The second approach used small-scale cork particulate inclusions dispersed between composite plies. Fabrication methods with vacuum-assisted resin infusion were found to be most suitable. The damping performance of the hybrid materials was found to significantly outperform the baseline composite at a range of frequencies without compromise to mechanical properties.

AUSTRALIAN STEEL FOR SUBMARINES

BlueScope Steel and Bisalloy Steels successfully supplied the steel plate for the Collins Class submarine fabrication and are now drawing on this experience, along with the help of UoW, to develop a modified 690 MPa candidate steel specifically designed to suit the construction of Australia's future submarines and their unique operating conditions.

High toughness is a critical performance requirement for steels for submarines and the research team has been experimenting with steel chemistry to achieve this, as well as new processing routes to resolve costly production difficulties encountered for the Collins steel. Several process modifications have proven to be successful and the resulting slab surface quality is excellent. The low temperature toughness has also been improved, however, further optimisation of the steel chemistry is still necessary to meet expected requirements.

The current iteration of steel chemistry provides a broader opportunity for structural applications and with further development, DMTC researchers anticipate that an Australian-produced steel can be certified for consideration for the submarine build program.

IMPROVING SONAR SENSITIVITY

Single crystal piezoelectric materials are the latest generation of acoustic transducer material that is expected to improve the sensitivity of sonar equipment. Single crystal piezoelectric materials are currently imported into Australia and this supply uncertainty is limiting local technology development. In response to increasing demand and need for supply certainty, DMTC has undertaken a feasibility study with Thales Australia and ANSTO to investigate single crystal growth technologies and production processes that will enable the establishment of a manufacturing capability in Australia.

After an evaluation of different crystal growth methods, the technology platform down-selected for the preparation of piezoelectric materials was the solid-state crystal growth process. The next phase of the study advanced the solid-state growth process for specific single crystal piezoelectric materials and established piezoelectric measurement protocols to assess their performance against equivalent polycrystalline materials. Selected compositions based on lead and non-lead formulations have now been grown by solid-state processes and characterised.

Continuing research is focused on optimising single crystal performance and process scale-up. Demonstrating large-scale processing capacity and its repeatability will enable single crystal piezoelectric technology to be considered for commercial production.

NEW ANTI-CORROSIVE COATINGS TRIALLED

Naval components require high wear and corrosion resistance, but conventional coating technologies, such as electroplating hard chrome (EHC) or plasma-sprayed ceramics are prone to micro-cracking and subsequent corrosion. DMTC participants MacTaggart Scott Australia, United Surface Technologies and SUT are developing a high velocity oxygen fuel (HVOF) coating technology in the pursuit of a better outcome.

Previous trials in collaboration with DST Group have demonstrated HVOF coatings are more dense and less porous than EHC, resulting in a final coating which has high antifouling, anticorrosion and excellent wear resistance. In-field underwater testing is now required to confirm increased corrosion resistance for Australian temperate waters. Several sites will be used to monitor coating performance and specially designed test rigs will simulate operating conditions. Following seawater trials, it is expected the developed technologies can be used in service.

United Surface Technologies technician Joel Goossens inspecting a corrosion resistant HVOF carbide-based coating (Photo: Andrew Siao Ming Ang)

LAND

Australian Army soldiers Lieutenant Hayden Lammiman and Private Josh Fidrmuc of the 2nd Battalion, Royal Australian Regiment, guide the unit's Bushmaster protected mobility vehicles into a position during Exercise Talisman Sabre 2015. (Photo: CPL Mark Doran)

ENHANCING THE PROTECTION OF PERSONNEL FOR MOUNTED AND DISMOUNTED OPERATIONS

PROGRAM LEADERS

ARMOUR APPLICATIONS
MR JAMES SANDLIN

PERSONNEL SURVIVABILITY
MR DEEPAK GANGA

While the Australian Army operates in an increasingly complex strategic environment characterised by rapidly evolving and non-traditional threats, its core mission – to win the land battle and protect the interests of Australia – remains.

Its range of vehicles are amongst the most advanced in the world and its modernisation program is modular, adaptive and increasingly interoperable.

Australian warfighters protective and combat equipment continue to evolve under the Army's modernisation planning and through the Diggerworks organisation.

DMTC's Land domain programs aim to enhance materials and manufacturing capabilities used in both mounted and dismounted land applications to keep the Australian Army at the cutting edge of warfare technology.

LAND DOMAIN OVERVIEW

Land-based systems are subjected to some of the most rigorous service environments of any engineered system. They must be sufficiently durable to perform in battlefield conditions where they are exposed to weather, dynamic loading conditions, chemical exposure, blunt impact and rough handling, while performing consistently and reliably.

The R&D undertaken in the Mounted and Dismounted programs aims to improve the performance of materials used in land-based systems, while reducing weight to increase both the payload and mobility of soldiers and vehicles. To this end, programs are evaluating the performance and potential applications of emerging metals, ceramics and synthetic materials as well as new manufacturing methods.

The Dismounted program has matured several technologies to prototype stage, including a lightweight combat helmet shell, portable fuel cell, lighter weight soft armour and fragmentation resistant combat uniform fabric. The prototypes illustrate potential capability improvements, in the areas of soldier protection and/or reduced weight.

Research into Mounted Land technologies has successfully completed its initial research life and is now moving into a new phase with new projects.

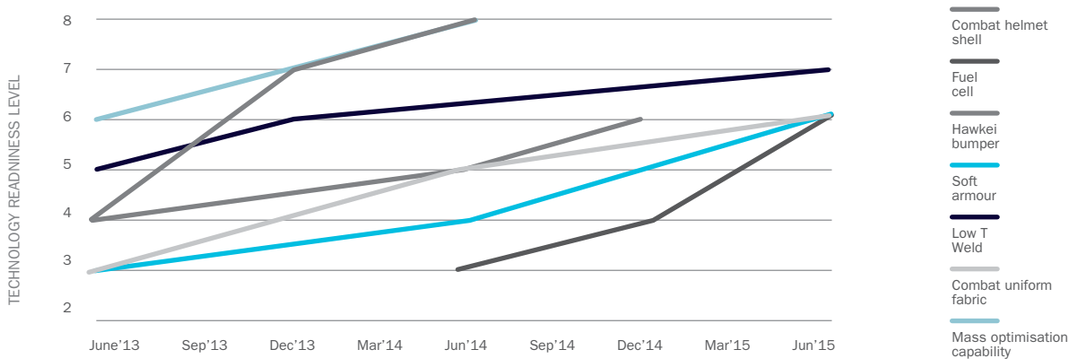
Forty technologies have been investigated and developed in the DMTC Land domain programs. These technologies range in application from new techniques for characterisation and modelling of materials in military service through to improved vehicle production and protection technologies – increasing the value and safety of land platforms on offer from Australian industry.

Building on the strengths and knowledge developed in DMTC's initial seven years, the Mounted Land technology portfolio is developing in complexity and depth. Three projects have evolved:

— Evaluation and incorporation of emergent materials into simulations for armoured vehicle design
— Development of augmented and hybridised powered systems to improve the supply/demand balance in vehicle powered systems
— Using computing advances to create more holistic and complex systems level models of vehicle platforms

These three projects are at the core of DMTC's developed expertise and will form the platform for future expansion of the program.

CAPABILITY DEVELOPMENT TRAJECTORY



Hawkei undergoing water fording testing.
(Photo: Department of Defence)

LAND HIGHLIGHTS

ADA's Senior Pattern Maker Rebecca Cooper models a prototype uniform designed to better protect soldiers from blast debris. (Photo: MB)

WELDING PROCESSES SIMPLIFIED

Joining of armoured steels is a technically detailed and sophisticated process, which DMTC has recently simplified using low cost technology. Using traditional methods, the steel must be pre-heated, welded hot and cooled slowly. This is due to the propensity of high hardness steels to adsorb hydrogen, becoming brittle and cracking post welding.

Using a metallurgically different filler material (austenitic steel), former DMTC PhD student and DMTC Project Leader Dr Lenka Kuzmikova led her team to develop a weld process requiring little to no preheat (depending on ambient temperature). Eliminating the complex thermal and welding cycles will allow industry to improve efficiencies when manufacturing armoured platforms.

The work was based on Dr Kuzmikova's DMTC-sponsored PhD thesis, and in mid 2013 transitioned to a full stand-alone research activity. The completed body of work is now being reviewed by a national standards committee to facilitate broad industrial adoption.

UNEVEN WEAVE FOR SUPERIOR SOFT ARMOUR

The soft armour project team has concluded a three-year investigation into uneven weave fabrics, a concept initially developed by DST Group and CSIRO, to yield a lighter soft armour. Modelling by DST Group showed that uneven weave design could yield improved ballistic performance compared to plain weave structures, and hence lead to a lighter soft armour pack.

The technical challenge was producing this novel weave structure on a commercial scale. Overcoming this challenge required a close working relationship between DST Group, CSIRO, Bruck Textiles and ADA. Through a process of identification, testing and scale-up, the team was able to identify suitable yarn combinations, optimise the weaving parameters and transfer the technology to a commercial scale.

Ballistic tests indicate that the uneven weave fabric could yield a soft armour pack that is up to 24% lighter than a conventional soft amour for the same level of protection.

SPIN-OFF TECHNOLOGIES PROVIDE COMPETITIVE EDGE

One of DMTC's project teams working on the construction of components for armoured vehicles has spent several years looking into the failure modes of bolted and welded joints subjected to catastrophic events (e.g. blast and ballistic impact). Along the way, they have had to develop techniques enabling these events to be simulated in a laboratory setting. The resulting spin-off technologies, many of which are world firsts or first in Australia, have or are being adopted by Australian defence industry. They include:

- Fatigue life models of welded joints (developed by BlueScope Steel and UoW)
- Bolted joint failure simulations (developed by UoM with support from Thales Australia)
- Ballistic evaluation of new Ultra High Hardness Steels (UHHS) (developed by Bisalloy Steels and evaluated by DST Group)
- New high strain rate (HSR) tensile capabilities for evaluation of armoured steels (developed by SUT and Thales Australia)
- New explosive bonding techniques (developed by DST Group)
- Low distortion stress relieving heat treatments for Cr-Mo space frames (developed by UoW and Thales Australia)

Each of these technologies provides a competitive edge to defence industry, enhancing the ability to design and fabricate new generations of lighter and better-protected land platforms.

PERSONAL FUEL CELLS UNDER TRIAL

The number of electronic devices used by a dismounted solider is continuing to rise and as a result there is an increasing need for portable power. New battery technologies are reducing some of the burden of battery weight, however extended operations still necessitate spare batteries. On a 72-hour mission, an individual soldier carries at least 4kg of spare batteries.

The research team consisting of DST Group and Horizon Energy Systems have developed a Personal Fuel Cell (PFC) system for the individual soldier. The PFC slots seamlessly into the existing load carriage equipment and uses a non-volatile fuel source making it ideally suited to the rugged military environment. The PFC produces up to 480Wh of energy for charging batteries at up to 15V. This will provide enough charging capacity to replace the 4kg of spare batteries with a 2kg PFC. A prototype PFC system has been delivered to Diggerworks for evaluation and integration trials.

HIGH STRENGTH FABRICS OFFER DEBRIS PROTECTION

The wide use of IEDs in the Iraq and Afghanistan conflicts led to an increase in extremity injuries from flying debris. So, three years ago, the high-strength fabrics team set out to capitalise on new developments in fibre science by developing a combat uniform that could offer greater protection.

An important outcome of having all levels of the supply chain represented in the project team was rapid transfer of technology from the laboratory to the factory floor. Technology supporting weaving, dying and printing of polyethylene and aramid blended fabrics was transferred to Bruck Textiles; and technology allowing integration of the new fabrics into garments was transferred to ADA.

The fabrics developed offer greater protection from flying debris than the current uniform fabrics. Three prototype uniforms were designed and produced to demonstrate the new fabric's potential extremity protection. The prototype uniforms were delivered to Diggerworks.

AUTOMATED MANUFACTURE AND ASSEMBLY SUCCESS

With an initial strategy to adapt existing software and hardware packages to automated assembly challenges, DMTC's Automated Off-Line Programming team has instead created a world-class, bespoke capability in fabricating armoured platforms and other large-scale assemblies.

The capability first implemented on the Bushmaster vehicle is currently completing up to 98% of all hull welding in an automated fashion using just a single assembly cell. The team included personnel from UoW, Bisalloy Steels and Thales Australia, and the technology has been extended beyond land vehicles to the sea domain and civilian applications. This successful technology has been licenced to UoW to facilitate broad industry adoption beyond defence and can truly provide an edge to Australian manufacturers.

The technology allows for the simulation of the assembly activity based on digital models and digital design drawings of the equipment to be assembled. During simulation, the most efficient path for the assembly robot to follow is determined and output as machine code, defining the path the robot will follow in the physical activity. Sensors mounted to the robot and within the assembly cell allow for any deviations between the design and physical components to be detected and adapted to.

The end result is a flexible manufacturing capability that can produce many assemblies from the same set of robotics, as well as the ability to program an assembly line in a fraction of the time traditionally taken in physically determining the assembly path.

Alvaro Carvajal is ADA's International Product and Business Development Manager (Military and Tactical Range. (Photo: MB)

AIR

The RAAF's JSF aircraft (Photo: Department of Defence)

IMPROVING AIRCRAFT SUSTAINMENT PRACTICES AND SUPPORTING NICHE AIRCRAFT COMPONENT MANUFACTURING CAPABILITIES

PROGRAM LEADERS

PROPULSION SYSTEMS
DR MATT DARGUSCH

AIR PLATFORMS
DR SURESH PALANISAMY

DMTC's Air Domain programs focus on achieving key advancements in the manufacture and sustainment of military aircraft.

Programs are guided by the RAAF's medium-to long-term air capability goals. Thus, work has been underway on platforms such as the F-18 Super Hornet and JSF.

DMTC project teams are improving capability in the areas of composite repair, corrosion, additive manufacturing, machining, as well as fatigue and structural health monitoring (SHM) for these platforms.

Ultimately, DMTC's Air Domain programs will equip Australian industry with the necessary expertise to capitalise both on global supply chain and domestic opportunities when the RAAF introduces these aircraft into service.

AIR DOMAIN OVERVIEW

DMTC's Air Platforms program continues to support the creation of improved aircraft component production, sustainment and repair capabilities in the key areas of component machining, direct manufacturing, and sustainment.

The program's focus in FY2015 was to deliver real capability outcomes to industry participants to improve the sustainability of aerospace manufacturing processes within Australia's industry supply chain.

DMTC's collaborative model has realised some key successes in this program; several sustainable manufacturing practices have been established and new technologies have been transferred to SMEs, enhancing their capabilities and linking them with prime defence contractors.

In particular, the use of advanced manufacturing technologies on titanium alloy aircraft components has provided industry participants with a competitive edge in terms of both cost and capability, improving the manufacturing of vertical tail components for the JSF aircraft.

DMTC's work on supply chain improvements in the manufacture of military aerospace components was recognised at the Avalon International Airshow 2015, where DMTC won the Aerospace Australia Defence Industry SME Innovation Grant.

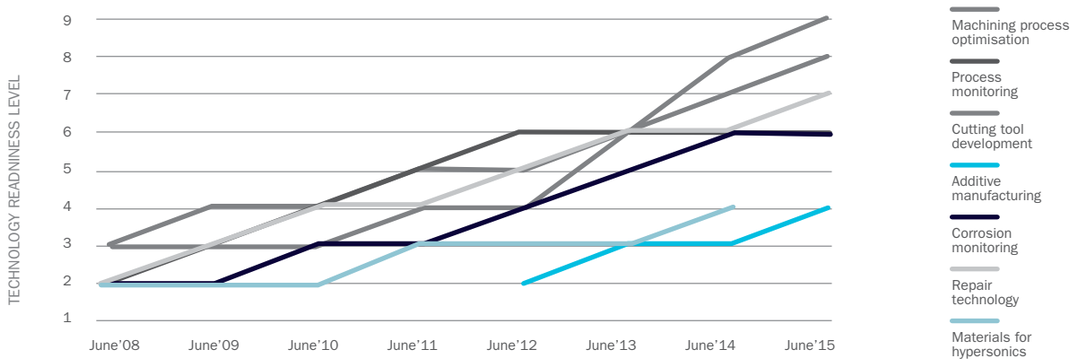
Project teams also successfully demonstrated the usefulness of additive manufacturing technologies through a benchmarking exercise with several industry participants.

DMTC's Propulsion Systems program is helping to reduce the cost of repairing damage to the aircraft structures and components for the extension of ADF aircraft service life.

The program has addressed key challenges associated with the development of new technologies to repair aircraft structures and components, and has developed new materials capable of withstanding extended exposure to the extreme conditions associated with hyper and supersonic flight.

Research under this program has included advanced surface engineering and repair technologies capable of enhancing or restoring structural and component performance and the assessment and certification of the technologies for aircraft structures and engine components. It has also developed fabrication methods for high temperature carbon composite and ultra-high temperature ceramics.

CAPABILITY DEVELOPMENT TRAJECTORY



BAE Systems' staff Paul Salerno, Senior Production Engineer, Robert Andrews, Senior Production Engineer and Isaiah Borgas, Deputy Project Manager, with DMTC's Air Platforms Program Leader Suresh Palanisamy with BAE's BTP machine. (Photo: MB)

Joseph Phung and Dr Steve Dowey of Sutton Tools are involved in DMTC's new tooling capability development project. (Photo: MB)

LOCAL TITANIUM MACHINING CAPABILITY

DMTC has continued to deliver outcomes in machining projects this year, including a project focused on new SME engagement in BAE Systems' supply chain. The project included a sponsored machining trial to promote and establish an Australian titanium capability with the purpose of attracting and retaining titanium contracts. A preliminary assessment of SMEs from all around the country was conducted to down-select a group of companies deemed capable of producing a roughed titanium part.

These companies were invited by DMTC and BAE Systems to participate. The project team provided the advanced titanium machining tooling knowledge generated from the DMTC projects to the SMEs. Then participants conducted a trial over a two- to three-month period and returned their results to BAE Systems for assessment - all participants produced high quality trial parts.

Based on the success of the trial, an initial supply chain partner was selected and is now part of the BAE Systems supply chain in rough machining titanium parts for the global JSF program. In addition to this program, there are many other aerospace opportunities that are increasing demand in the Australian market.

SUTTON TOOLS LANDS JSF SUPPLY CHAIN ROLE

Sutton Tools has reported a significant boost in business through its participation in DMTC's Air Platforms program over the past six years. The research work carried out in the 'New tooling development' project led to the company successfully regrinding and recoating several tools used in aerospace component manufacturing at their Advanced Surface Solutions Facility.

These tools require high-precision grinding and also need appropriate coatings to be applied to make them reusable in the aerospace components machining application. DMTC's research activities have been focused on the development of these tooling solutions. The tools are used by Australian SMEs that machine aerospace components, including for the JSF program.

DMTC projects with Sutton Tools have also resulted in new supply deals for the company globally. Their tools are currently being used in China, Singapore, Thailand and Germany.

ADDITIVE MANUFACTURING BENCHMARKING

An Additive Manufacturing Benchmarking project sponsored by the Victorian Government through the Manufacturing Productivity Networking grant program was undertaken by DMTC. The aim was to bridge the gap between technical capability and industry uptake of additive manufacturing.

Four additive manufacturing techniques were compared for application on metallic components; selective laser melting, electron beam melting, direct metal deposition and wire and arc additive layer manufacturing. The program examined the evolution and character of the deposited metal for each of the four processes, and went on to conduct a cost benefit analysis of their application. Finally, DMTC held a workshop to promote the outcomes to industry.

One of the SMEs in this project was Bauer Engineering, which is responsible for machining several additive manufacturing components.

Through this process, they have generated very useful knowledge about finish machining and have consequently won new contracts to machine additive manufactured parts – a significant win for Australian manufacturing.

LASER CLADDING TECHNOLOGY FOR REPAIRS

In-service damage from corrosion, wear or debris impact is increasingly common with ageing military aircraft fleets. Maintenance of aircraft components with this type of damage can be expensive and have a significant impact on fleet availability.

Over the past seven years, a DMTC project team involving industry partner RUAG Australia has investigated and delivered repair technologies to restore aluminum and titanium alloy components.

As part of this process, RUAG Australia has implemented DMTC technologies and prepared procedures for the repair of a range of defence components. The DMTC project has undertaken extensive experimental and field trials to support RUAG Australia's certification process for the repair of the components.

Another significant outcome has been the development of a graphical user interface using optimised laser cladding parameters for a range of substrate and clad layer alloy systems. The GUI is a user-friendly, stand-alone program designed to guide the operator to select optimal laser clad parameters. It is an important tool that will enhance the company's ability to deliver sustainment outcomes to Defence.

This project also demonstrated that it is feasible to use laser cladding repair to restore component shape and strength, in particular on external component surfaces. Further work is being carried out to apply the technology in applications subjected to very high fatigue loads.

The new laser cladding technology developed in this project, and the outcomes delivered to RUAG Australia, will underpin future DMTC collaborations on repair technologies.

DMTC project team members with SUT's new CNC machine. L to R: postdoctoral research fellow Rizwan Adbul Rahman Rashid and Girish Thipperudrappa, senior technician.

DMTC PROJECTS

A TOTAL OF 224 PROJECT MILESTONES WERE REACHED DURING DMTC'S INITIAL SEVEN-YEAR TERM

BAE Systems' Machinist Jamie Hunt shows machined titanium chips which are recycled into solid bars using the ECAP process. (Photo: MB)

SEA DOMAIN PROJECTS

NUMBER	TITLE	TECHNOLOGY FOCUS	STATUS
2.1	High strength steels for defence application	New Ferritic Materials and Joining Technologies	Complete
2.2	Surface processing technologies for repair and improved performance for submarine and surface ship components	Corrosion, Prognostics & Repair	Complete
2.3	Technology development for multifunctional composite structures	Composites, Component Integration	Complete
2.4	Lean automation technology for advanced manufacturing of marine defence components and assemblies	Joining Technologies, Performance Modelling and Simulation	Complete
2.5	Corrosivity of Australian naval bases	Corrosion	Complete
2.6	Performance optimisation in PZT ceramic by advanced materials processing for sonar applications	Niche Manufacturing Processes	Complete
2.7	Evaluation of candidate hull steels for submarine applications	New Ferritic Materials	Complete
2.8	Feasibility study single crystal piezoelectric ceramics	Piezoelectric Ceramics	Complete
2.9	Submarine hull modelling scoping study	Modelling	Complete
2.10	High velocity oxygen fuel carbide based coating for marine corrosion protection: preliminary study	HVOF Coatings	Complete
2.11	Maritime composite scoping study	Composite Materials	Complete
2.12	Development of solid state growth process for single crystal piezoelectric materials	Piezoelectric Ceramics	Complete
2.13	Investigating the short term biofouling characteristics of HVOF carbide-based coatings	Biofouling, HVOF Coatings	Complete
2.14	Carbide-based HVOF coatings for hydraulic components	HVOF Coatings	Complete

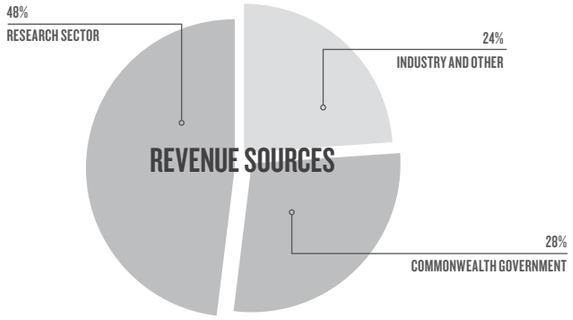
LAND DOMAIN PROJECTS

NUMBER	TITLE	TECHNOLOGY FOCUS	STATUS
3.1	Evolution of armour requirements and development of improved systems and manufacturing techniques	New Ferritic Materials and Joining Techniques	Complete
3.1c	Lower pre-heat welding technique for armour steels	Automated Manufacturing	Complete
3.2	Alternative 'next generation' ferritic armour system for vehicles	New Ferritic Materials, Performance Modelling, Simulation & Validation	Complete
3.3	Advanced personnel armour	Niche Manufacturing Processes, Performance Modelling, Simulation & Validation	Complete
3.4	Comparison of mechanical and welded joints for construction of components for armoured vehicles	Joining Technologies, Performance Modelling, Simulation & Validation	Complete
3.5	Lean automation technology for advanced manufacturing of armoured vehicles	Automated Manufacturing	Complete
3.6	Development and commercialisation of ceramic protective equipment	Niche Manufacturing Processes	Complete
3.7	Research, development, design and manufacture of a new combat helmet	Composites, Niche Manufacturing Processes	Complete
3.8	Alternate materials and manufacturing for next generation armoured vehicles	Composites, Titanium Component Fabrication	Complete
3.9	Investigation of blast mitigation performance and human injury	Performance Modelling	Complete
3.10	Soil model scoping study	Modelling Materials Characteristics	Complete
3.11	Evaluation of keyhole tungsten inert gas (TIG) welding on high hardness steels	Welding	Complete
7.1.1	Ceramic armour technologies	Niche Manufacturing Processes	Complete
7.1.2	High curvature armour systems	Niche Manufacturing Processes, Textile Technologies	Complete
7.1.3	Low profile body armour	New Ferritic Materials	Complete
7.2.1	Improved anti-ballistic soft armour	Composites, Textile Technologies, Performance Modelling, Simulation & Validation	Complete
7.3.1	High strength fabrics for combat clothing	Textile Technologies, Composites, Performance Modelling, Simulation & Validation	Complete
7.4.1	Portable power generation	Niche Manufacturing Processes	Complete
7.4.2	Portable power storage	Niche Manufacturing Processes	Complete

AIR DOMAIN PROJECTS

NUMBER	TITLE	TECHNOLOGY FOCUS	STATUS
1.1.1a	Development of new titanium fabrication technology	Machining	Complete
1.1.1b	Next generation tooling development	Cutting Tools	Complete
1.1.2	Advanced process monitoring tools and transfer to manufacturing supply chain	Process Monitoring	Complete
1.1.2b	Extended titanium benchmarking	Thermal and Coolant Management	Complete
1.3	Evaluation of titanium direct/additive manufacturing and robotic machining	Advanced Manufacturing	Complete
1.4	Laser direct manufacturing of small scale high value JSF type components	Advanced Manufacturing	Complete
1.6	Aircraft prognostic tools to reduce corrosion impacts	Health Monitoring	Complete
1.6.1	Distributed fibre optic paint degradation sensor	Corrosion	Complete
1.6.2	Cost of ADF aircraft corrosion	Corrosion	Complete
1.7	Rapid and reliable detection and analysis of composite defects	Non-destructive Testing	Complete
1.8	Development of heat treatment capability for beta titanium alloys	Heat Treatment	Complete
1.9	Evaluation of additive manufacturing and machining technologies	Advanced Manufacturing	Complete
1.10	Investigation of tool wear during machining of titanium alloy with cryogenic compressed air cooling	Machining	Complete
1.11	Residual stress of additive manufacturing	Advanced Manufacturing	Complete
4.1	Repair technologies for current and next generation aircraft systems	Repair	Complete
4.2	High temperature materials for hyper and supersonic flight	Advanced Materials	Complete
4.3	Advanced aerospace materials for supersonic, hypersonic flight	Advanced Materials	Complete

FINANCIALS AT A GLANCE – FY 2015



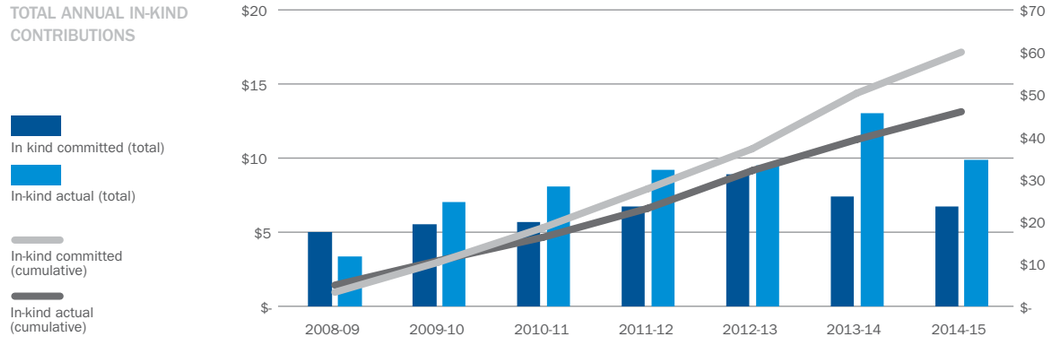
DMTC continued to focus its expenditure on the successful delivery of project outcomes across the existing portfolio of projects. DMTC receives a portion of its income from the Defence Future Capability Technology Centre Program and this is pooled with additional contributions from Australian industry, research agencies and other sources including State Governments.

Income for the 2014-15 financial year (FY2015) totalled $15.82 million which included $9.85 million of in-kind contributions from DMTC's industry and research Participants. In-kind contributions from industry and research Participants exceed commitments by 46% for the year and 31% on a cumulative basis by 30 June 2015. Cash contributions from industry and research Participants exceeded commitments pledged for both the FY2015 and cumulatively by 30 June 2015.

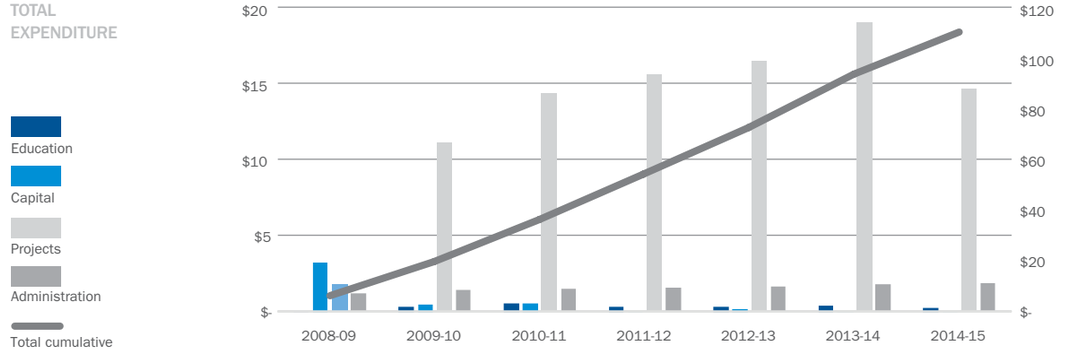
Cash on hand at 30 June 2015 totalled $4.48 million which included $2.96 million of unallocated funds received from the Commonwealth and State Governments. These funds will be applied to fulfill existing project activity in the FY2016 and to support new strategic research and education program activities that will grow participation in the Centre and which are of strategic importance to overall defence sector capability in Australia.

THE YEAR IN SUMMARY	2015 $	2014 $
REVENUE (TOTAL CASH AND IN-KIND)		
Commonwealth Government	4,500,000	6,800,000
Industry sector and other income	3,761,943	6,371,482
Research sector	7,554,968	8,665,040
	15,816,911	**21,836,522**
EXPENDITURE (TOTAL CASH AND IN-KIND)		
Capital	8,265	31,769
Education	206,725	346,297
Projects	14,731,619	19,151,732
Administration	1,887,125	1,797,354
	16,833,734	**21,327,152**
HUMAN RESOURCES SNAPSHOT		
Full time equivalent staff in-kind contributions	39.2	53.6
Postgraduate students	29	31
Centre management employees	9	9
	77	**94**

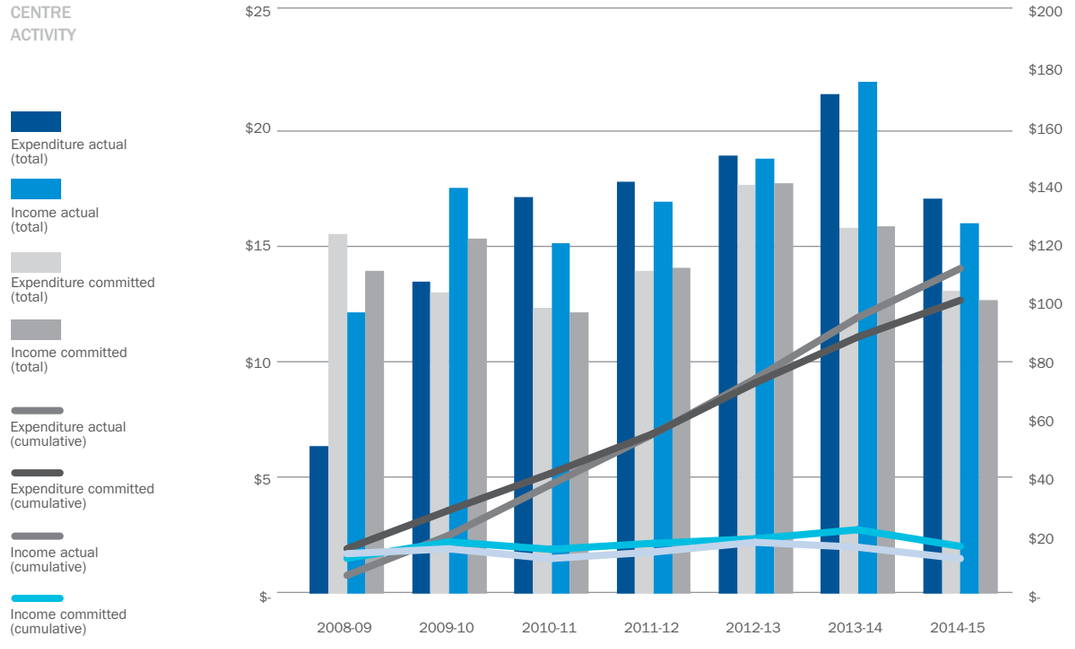
TOTAL ANNUAL IN-KIND CONTRIBUTIONS



TOTAL EXPENDITURE



CENTRE ACTIVITY



DMTC PhD candidate Nicholas Orchowski (RMIT University) is now employed by RUAG Australia as a Research & Technology Engineer. (Photo: MB)

EDUCATION PROGRAM

New knowledge, greater skills

Supporting the development of new talent, knowledge and skills is an integral part of DMTC's objectives. Developing new knowledge through our research programs is just the start of our skill creation activities.

DMTC takes a holistic approach to knowledge and skill development to ensure new knowledge is captured, embedded and leveraged by Australian businesses. In addition to research activities, DMTC supports new knowledge and greater skills through knowledge transfer projects, supporting students to work on real industry-led projects and through the commercialisation of new technologies. The DMTC Education Program activities include:

— an annual student conference where students present their research to their peers
— professional development workshops for broader skills development that align with the needs of DMTC industry and research partners
— competitive selection to present at the DMTC Annual Conference
— involvement in project reviews and research utilisation discussions with industry partners
— support to attend conferences

Year in review

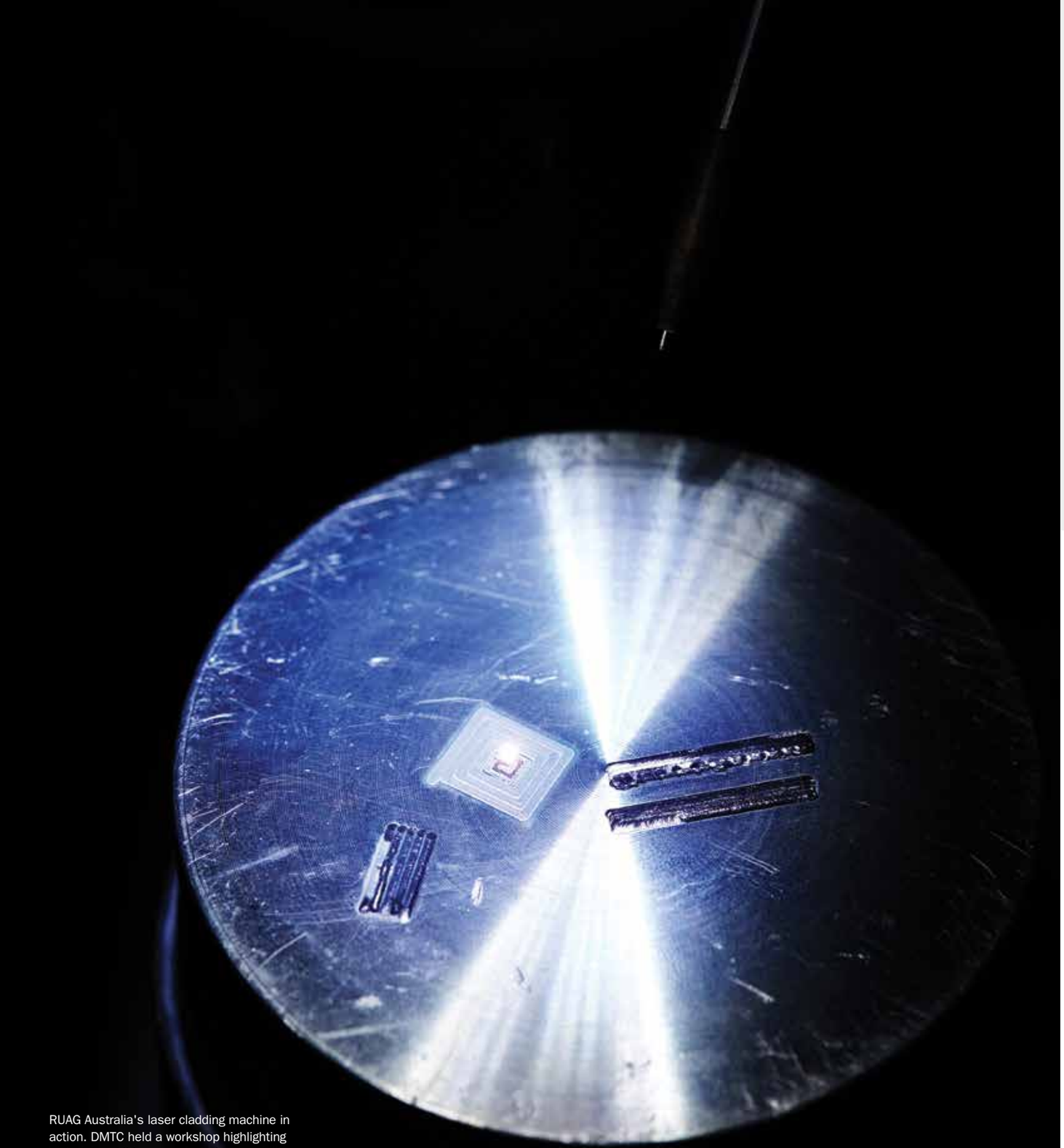
The DMTC Education Program had a successful year with the culmination of seven years of hard work by DMTC-sponsored PhD and Masters candidates. In the FY2015, 10 candidates were officially awarded their Doctor of Philosophy, bringing the total to 16, with another three awaiting official confirmation. A further 11 candidates are at various stages of competition.

DMTC-sponsored candidates and researchers had an incredible year with external recognition from external sources for excellence in research:

— Vanessa Lussini from QUT won the Aerospace Australia Young Innovator prize at the Australian International Airshow. Vanessa was presented the award for her outstanding work to improve the safety of aircraft and reduce maintenance costs associated with aircraft coatings.
— Tristan Alexander from Deakin University won the Land Defence Australia Young Innovator Scholarship presented at the Land Forces Conference. Tristan was presented the award as a result of his work in polymer ceramics for DMTC's personnel survivability program.
— Long Nguyen from RMIT University won the best poster prize at the ISB in Atlanta for his work on 'The effect of target thickness on the ballistic performance of UHMWPE composites'. The symposium's poster competition is extremely competitive with over 160 international entries.
— Muhammad Awais Javed from SUT won the Annual Brian Cherry Award. Awais was presented the award for his corrosion work on 'Acceleration or inhibition in MIC? It's your call'.

DMTC has continued to support the establishment of the Research Training Centre for Naval Design and Manufacturing and its placement of 10 PhD and three postdoctorates. DMTC has been providing in-kind support to the centre and will be running a series of workshops for its students over the coming years.

DMTC's Vacation Student program enabled the sponsorship of seven final-year engineering students to complete 12 weeks of vacation employment. Students were located at The University of Queensland, Sutton Tools, RUAG Australia and QUT.



RUAG Australia's laser cladding machine in action. DMTC held a workshop highlighting Victoria's additive manufacturing capabilities. (Photo: MB)

ANNUAL STUDENT CONFERENCE

DMTC held its Annual Student Conference in Melbourne on 21 and 22 October 2014, with 11 DMTC-sponsored PhD and Masters Candidates attending, along with 20 supervisors and representatives from industry and research institutions. Each student presentation was evaluated by an experienced panel.

The winners were:

SEA –	Muhammad Awais Javed, SUT
LAND –	Dr Rajneesh Jaitlee, RMIT University
AIR –	Nick Hoye, UoW

WORKSHOPS

Defence Trade Controls Act Legislation

In August 2014, DMTC held a workshop on the subject, 'The Defence Trade Controls Act Legislation: How will it affect you?'

The Department of Defence's Director for Strengthening Export Controls, Ms Claire Willette spoke about general issues arising from the Act and the implications for both industry (particularly SMEs) and researchers.

Clear Science Writing

In October 2014, DMTC ran a science writing workshop to develop the writing skills of DMTC-sponsored postgraduate students and other DMTC participant representatives. Twenty-five people attended.

Additive Manufacturing Benchmarking

A workshop highlighting Victoria's additive manufacturing capabilities was held for Victorian SMEs in October 2014. The workshop was part of the Additive Manufacturing Benchmarking project, sponsored by the Victorian Government through the Manufacturing Productivity Networking grant program. The practical applications of these technologies were discussed in light of the benchmarking project results.

POSTGRADUATE SNAPSHOT

DMTC-SPONSORED DEGREES AWARDED FY2015

DR JOSEPH POLDEN
UNIVERSITY OF WOLLONGONG

Automated offline programming for low volume robotic manufacturing

Dr Joseph Polden's PhD thesis focused on the programming of industrial robots for manufacturing applications. Mass production of robotic devices has significantly reduced their cost, however, programming these robots in a cost-effective manner is still difficult and poses many challenges to industry. The research conducted in Dr Polden's thesis focused on developing a virtual environment in which industrial robot programming can be carried out. In this setting, virtual models of the robots and their environment are used to create, simulate and validate robot programs before they are uploaded into real-world robotic systems. By programming robots this way, automation can be introduced into the programming process, significantly reducing programming times and also optimising the overall process.

Dr Polden's project involved industry partner Thales Australia, which utilises a complex robotic system for welding. With new product variants expected, the anticipated cost of re-programming a robot cell to perform the required manufacturing tasks was very high. As a result of the work carried out during Dr Polden's thesis, he was able to provide the industry partner with a programming method that significantly reduced their operating costs.
Dr Polden enjoyed witnessing the process of technology development from concept through to a functioning, useful piece of technology.

Shortly after finishing his PhD, Dr Polden joined a manufacturing research institute in Singapore, where he now works on robotic manufacturing for SME applications.

DR CAMERON BARR
THE UNIVERSITY OF MELBOURNE

Equal channel angular processing of nickel aluminium bronze (NAB) for marine platforms

Dr Cameron Barr's research focused on enhancing the performance of NAB, an alloy widely used in maritime platforms for its combination of high strength and corrosion resistance. The goal of the project was to eliminate the vulnerability of NAB to selective phase corrosion (SCC), while providing significant increases to the yield strength. In doing so, the use of NAB could be expanded to ultra-high strength applications currently filled by stainless steels, which do not share the same resistance to corrosion as NAB and risk galvanic coupling with other NAB components. The outcomes of this work will enable enhanced capability and significant cost savings to Defence through a reduction in expensive component replacements.

Equal channel angular pressing (ECAP) was used to subject ingots of NAB to extreme strains, leading to a significant reduction in grain size (from 50 µm to 700 nm) and a breakdown of the lamellar phase known to cause SCC into very fine fragments (~ 350 nm). This not only prevented SCC from penetrating into the material, but also provided major strengthening through the small fragment and grain sizes, with the yield strength increasing from 275 MPa to over 950 MPa. Several models were developed to predict the yield strength and microstructure following ECAP and subsequent heat treatment. These models can be used to guide the development of new copper-based marine alloys.

Dr Barr plans to continue his materials research and explore the opportunities presented by emerging technologies and techniques. He hopes to further develop his analytical and modelling skills through his PhD.

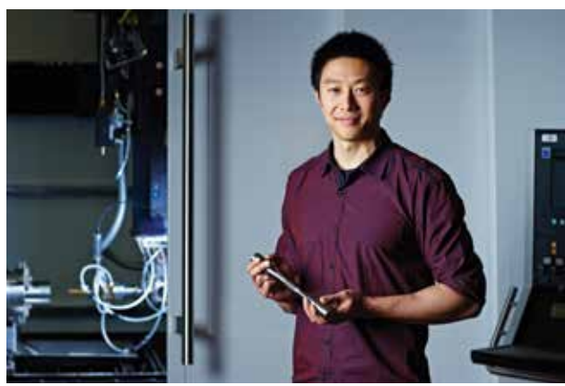
DR SHI DA (STEPHEN) SUN
RMIT UNIVERSITY

Laser metal deposition (LMD) repair for aircraft landing gear component

Dr Stephen Sun's research explored the possibility of implementing LMD to repair ultra-high strength steels in fatigue critical load carrying aerospace components, such as aircraft landing gear. The main objectives of his work were to assess the microstructure, fatigue and mechanical properties of the as-clad, and then compare the results to the substrate baseline condition. Dr Sun developed a processing strategy to successfully rebuild geometry using LMD with a defect-free clad layer, a small heat-affected zone and improved mechanical and fatigue material properties. The results showed that LMD offers a very promising path to restore and possibly increase the structural integrity of damaged ultra-high strength steel components.

The research was part of a larger project: Project 4.1 – Repair Technologies for Current and Next Generation Aircraft Systems. This project investigated the feasibility of restoring a range of aerospace components, which suffer damage exceeding permissible limits, to the required minimum level of performance using LMD. Dr Sun was the lead investigator into the repair of steels.

Dr Sun is continuing his research at the RMIT University Centre for Additive Manufacturing as an LMD specialist. His career aspiration is to develop LMD technology for industrial collaborations in additive manufacturing and repair of high valued, complex mining and aerospace components.
His goal is to combine research and process development to allow users to maximise the useful service life of costly parts, so that component replacement may be avoided.



MR JIMMY TOTON
RMIT UNIVERSITY

The design, characterisation and application of an accelerated drill test for cutting tool development

Mr Jimmy Toton was awarded his Master's degree by research in December 2014. His thesis focused on designing and developing a timely and low cost accelerated drill test that could accurately and repeatedly determine differences in tool life with a high level of confidence. Mr Toton's research work directly supported DMTC project 1.1.1b with the aim to develop and optimise cutting tools for the production of components made from the latest aerospace composites and alloys. These DMTC projects required extensive use of the developed test in order to verify and then optimise their design features for maximum tool life and productivity.

Mr Toton's research resulted in the development of a robust and sensitive accelerated drill test through management of machining complexity, lowered variance and the empirical modelling of sources of machining variance. For accelerated testing of high speed steel cutting tools, an abrasive wear model was found to be preferable over thermo-chemical wear types. The model allowed experimental cutting tool designs to be compared reliably over multiple tests.

Mr Toton is continuing his studies and research with the DMTC at RMIT University with industrial partner Sutton Tools. Mr Toton is now conducting research that aims to determine the current capability of metallic 3D printing technology to reduce production times and costs, offer novel powder based tool materials with increased wear resistance and utilisation of the near-net-shape fabrication capability. This will enable design and manufacture of cutting tools with enhanced tool life and productivity characteristics compared with the current state-of-the-art high performance tooling technology.

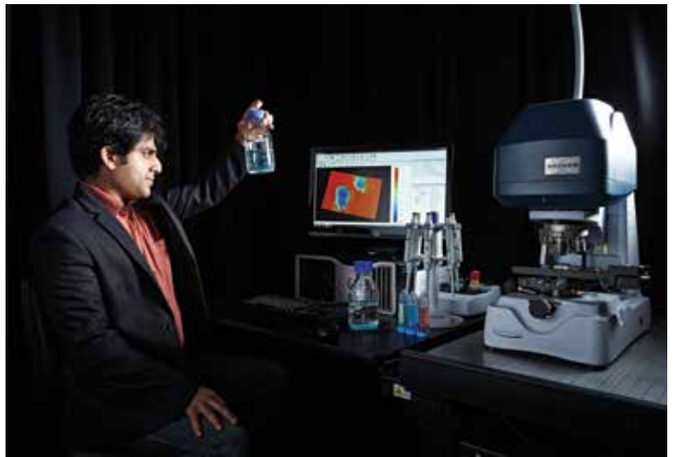
DR MUHAMMAD AWAIS JAVED
SWINBURNE UNIVERSITY OF TECHNOLOGY

Microbiologically influenced corrosion of carbon steels

Dr Muhammad Awais Javed was awarded his PhD in 2015. Dr Javed's doctorate thesis investigated the factors affecting MIC of carbon steels in lab-based studies. MIC is the initiation, facilitation, acceleration and/or inhibition of corrosion due to the presence and activities of microorganisms. It is an interdisciplinary subject and can involve a range of scientific and engineering fields such as metallurgy, chemistry and microbiology. The industries most affected by MIC include maritime, chemical processing, nuclear power, oil and gas production, and waste water treatment.

Dr Javed's research work was related to DMTC Project 2.5 – Corrosivity of Australian Naval Bases. The key objective of this project was to investigate the composition of port/harbour waters, determine the presence of MIC-related microorganisms in these waters and establish a link between the composition of port/harbour waters and corrosion. Dr Javed's research investigated the effect of different metallurgical, chemical and microbiological factors on the initial bacterial attachment and subsequent MIC of carbon steels. The findings from his research will help to design more rigorous lab-based tests of MIC that can be used to support the development of mitigation strategies for MIC attack in actual field conditions.

Dr Javed has commenced work as a doctoral researcher at SUT, working on MIC performance of candidate piping materials.



DR NICHOLAS HOYE
UNIVERSITY OF WOLLONGONG

Characterisation of Ti-6AL-4V deposits produced by arc-wire based additive manufacture

Dr Nicholas Hoye was awarded his PhD in 2015. The primary aim of his postgraduate research project was to investigate the use of arc-wire deposition techniques based on the gas tungsten arc welding process for the additive manufacture of freeform structures from the Ti-6Al-4V titanium alloy. Dr Hoye focused on four key aspects of the process: characterisation of geometry and microstructure of additively manufactured structures, evaluation of mechanical properties, influence of welding process parameters on residual stresses in these structures, and extent and effects of atmospheric contamination during the manufacturing process. Mechanical testing indicated comparable properties between conventionally processed and additively manufactured materials, with post-weld atmospheric contamination having no discernible effect on the properties. Additionally, it was shown that conventional post-weld heat treatments are effective in relieving residual stresses formed during the additive manufacturing process.

Dr Hoye's research contributed significantly to DMTC Project 1.3 – Evaluation of Titanium Direct/Additive Manufacturing. The findings of this work indicate that the arc-wire based additive manufacture process shows promise in substantially reducing the manufacturing costs associated with structural titanium components by increasing material utilisation and reducing machining requirements. The outcomes of the project were also considered to be a foundation for the development of knowledge and enabling technologies for Australian manufacturing companies.

With his postgraduate studies completed, Dr Hoye has taken a research fellow position at UoW. This has seen him continue collaborative research with both DMTC and the Industrial Liaison Office of the Bragg Institute at ANSTO. In addition to his industrially focused research activities, Dr Hoye is actively involved in the development and delivery of course materials and teaching aids for undergraduate engineering subjects at UoW.

DR MOHAMMAD MEHDIZADEH
RMIT UNIVERSITY

The durability, functionality assessment of SHM systems in multi-functional composites

Dr Mohammad Mehdizadeh's dissertation reports on the development of novel techniques to assess the functionality and reliability of SHM systems in multifunctional composites. The performance of multifunctional composites can be affected by the degradation of their subsystems. SHM systems have emerged as a feasible method with which to improve the reliability of multifunctional structures. However, the reliability/functionality of SHM systems can be affected by erroneous information from its sensors and actuators (transducers). Improving reliability requires a new capability to delineate failures associated with a transducer network from the damage in the structure being monitored. The aim of this research was to establish techniques/technologies to provide this capability to address the main gap in the certification of SHM systems. Dr Mehdizadeh's work was directly related to DMTC Project 2.3 – Technology Development for Multifunctional Composite Structures.

Three novel techniques were presented to address various damage/degradation scenarios in the composite. The strain-based method provided a delineation technique to detect damage when transducer and composite structures are subjected to fatigue loading. The electromechanical-impedance-based technique established a methodology that makes it possible to continue using degraded SHM systems to delineate various damage scenarios. The sensitivity of piezo-fibre transducers to electromagnetic interference, which was not previously reported in literature, was employed to detect transducer damage and identify the degraded subcomponent ie. piezo-fibres, electrodes.

Dr Mehdizadeh will be looking to expand his research in smart multifunctional composites into more complex applications. His career goal is to become a professor at one of the world's leading educational institutions.

PHD AND MASTERS CANDIDATES

Over the seven-year life of DMTC, 34 postgraduates have been supported through scholarships and professional development courses. Postgraduate scholarships are awarded based on alignment with the future defence capability requirements and industrial opportunities for Australian industry. To date, 16 DMTC-sponsored PhD candidates have been awarded their Doctor of Philosophy, with others at various levels of competition. There are 13 active PhD candidates with scholarships and involvement in the DMTC Education Program.

THOSE WHO WERE CONFERRED THEIR DEGREES IN 2014-15

NAME	INSTITUTE	RESEARCH TITLE	DOMAIN
Cameron Barr	The University of Melbourne	Equal Channel Angular Processing of Nickel Aluminium Bronze for Marine Platforms	Sea
Damith Jayasekara	The University of Melbourne	The Use of Polymer Coating to Enhance the Projectile Impact Resistance of Steel and Aluminium Plate Structures	Land
Jimmy Toton	RMIT University	Metal Cutting Mechanics and the Challenges of Real Life Cutting Tool Testing	Air
Joseph Polden	University of Wollongong	The Automation Assisted Manufacture of Defence Vehicles and Land Platforms	Land
Manasa Kesharaju	Swinburne University of Technology	Ultrasonic Sensor-based Approach to Defect Detection and Characterisation of Armour Ceramics	Land
Mohammad Mehdizadeh	RMIT University	The Durability, Reliability and Functionality of SHM Systems in Multifunctional Composites	Air
Muhammad Awais Javed	Swinburne University of Technology	Role of Metallurgical Features on Microbiologically Influenced Corrosion (MIC) of Ferrous Substrates	Sea
Nicholas Paul Hoye	University of Wollongong	Control of Material Properties in Wire-arc Deposited Welds of Titanium Alloys	Air
Peng Luo	The University of Melbourne	Recycling of Ti Machining Chips	Air
Shi Da (Stephen) Sun	RMIT University	Laser Cladding of High Strength Steel for Aerospace Applications	Air

CURRENT POSTGRADUATE PROJECTS

NAME	INSTITUTE	RESEARCH TITLE	DOMAIN
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
Long Nguyen	RMIT University	Ballistic Performance of UHMW Polyethylene Armour	Land
Michael Wang	The University of Melbourne	Modelling Two-Phase Material properties Using Monte Carlo approach	Air
Mitchell Sesso	Swinburne University of Technology	Design of Thermal Barrier Coatings for Hypersonic Applications	Air
Mya Myintzu Hlaing	Swinburne University of Technology	Study of Factors Influencing Bacterial Biofilm Formation	Sea
Nathan Lane	University of Wollongong	An Investigation into the Toughness and Weldability of High-Strength Steels for Australian Naval Surface Vessels	Sea
Nicholas Orchowski	RMIT University	Investigation into the Post-Repair Performance of Ti6Al4V after the Occurrence of Foreign Object Damage	Air
Paul Mignone	The University of Melbourne	Modelling Two-Phase Material Properties Using Finite Element Analysis and Microstructure	Air
Silvia Leo	The University of Melbourne	Colloidal Processing of Difficult to Densify Ceramics	Land
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
Toby Joel 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

MANAGEMENT

DMTC maintains an efficient operational structure with a low overhead cost to the business. The management team are committed to the business's objectives and ensure maximum funding and resources are directed to our research and technology development activities.

BOARD OF DIRECTORS

MR TONY QUICK, CHAIR

APPOINTED 27 MAY 2008, RE-ELECTED 7 NOVEMBER 2013
APPOINTED AS CHAIR IN DECEMBER 2010 MA (CANTAB)

Mr Tony Quick is independent Chair and non-executive director of Quickstep Holdings Ltd. 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 a former Chair of the Design Victoria Advisory Board and was the Textiles, Clothing and Footwear Supplier Advocate from 2011 to June 2014. He is an Adjunct Professor in the School of Aerospace, Mechanical and Manufacturing Engineering at RMIT University.

Meetings attended: 6/6

DR ROGER LOUGH AM, DEPUTY CHAIR

APPOINTED 14 NOVEMBER 2008, RE-ELECTED 13 NOVEMBER 2014
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 the Defence Science and Technology Organisation (DSTO). Dr Lough completed his public service as Chief Defence Scientist and CEO of DSTO between 2003 and 2008. Dr Lough is Chair of the Defence Science Institute and member of the Victorian Defence Council. He is a Fellow of the Australian Academy of Technological Sciences and Engineering (ATSE) and was made a Member of the Order of Australia in 2009. Dr Lough has a PhD from Adelaide University.

Meetings attended: 5/6

DR JOHN BEST, DIRECTOR

APPOINTED 11 NOVEMBER 2009, RE-ELECTED 7 NOVEMBER 2013
PHD, 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 Ltd in 2003 and was appointed as CTO 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 Ltd followed a 15-year career with DSTO. Dr Best is a director of Eurotorp Pty Ltd and member of the University of Technology Sydney Faculty of Engineering and IT Industry Advisory Network. Dr Best is a member of the DMTC Ltd Audit, Risk and Remuneration Committee.

Meetings attended: 5/6

MRS BRONWYN CONSTANCE, DIRECTOR

APPOINTED 25 NOVEMBER 2010
FCPA (AUSTRALIA), FCIS, FAICD, RE-ELECTED 13 NOVEMBER 2014

Mrs Bronwyn Constance has held many senior executive positions including finance director of Kraft Foods Ltd Australia and New Zealand, Vice President Finance of Kraft Foods Asia, Executive General Manager Finance and Administration of Pasminco Ltd and finance director of Nylex Ltd. She spent her early career with the ACI Group of companies. Mrs Constance is an independent director of CRC CARE Pty Ltd and Rail Manufacturing CRC Ltd. She is a former independent director of Colorpak Ltd, the Melbourne Market Authority, Plantic Technologies Ltd, The Just Group Ltd and the CRC for Advanced Automotive Technology. Mrs Constance is Chair of the DMTC Ltd Audit, Risk and Remuneration Committee.

Meetings attended: 6/6

MR MICHAEL GROGAN, DIRECTOR

APPOINTED 5 DECEMBER 2013, ELECTED 13 NOVEMBER 2014

Michael Grogan is the CEO of Sutton Tools Pty Ltd, an Engineering Manufacturer producing and exporting a full range of Cutting Tools from three Australian facilities and one New Zealand facility. Mr Grogan is Chair of the Inner Northern Local Learning and Employment Network, Board member of the Manufacturing Skills Australia – Industry Skills Council and member of the Victorian Manufacturing Skills and Training Taskforce. Mr Grogan is a member of DMTC Ltd's Audit, Risk and Remuneration Committee.

Meetings attended: 6/6

DR PETER JONSON, DIRECTOR

APPOINTED 25 NOVEMBER 2010, RE-ELECTED 13 NOVEMBER 2014
BCOM, MA (MELBOURNE), PHD (LONDON SCHOOL OF ECONOMICS)

Dr Peter Jonson is a director of Village Roadshow Ltd. He is Chair Emeritus of the Melbourne Institute, and Chair of Paranta Biosciences Ltd, Care CRC Pty Ltd and interim Chair of the Innovative Manufacturing CRC. He is an adjunct professor at RMIT University and principal research fellow at UOM. Dr Jonson is a former Chair of the Australian Institute for Commercialisation, AADI Ltd, Bionomics Ltd and the Federal Government's CRC Committee. Dr Jonson worked for the Reserve Bank of Australia for 17 years as an economist and for seven of those years, held the position of Head of Research. He was CEO of Norwich Financial Services Ltd and Managing Director and Chair of ANZ Funds Management. He is a Fellow of the Academy of the Social Sciences in Australia.

Meetings attended: 6/6

PROFESSOR JOHN NORRISH, DIRECTOR

APPOINTED 27 MAY 2008, RE-ELECTED 7 NOVEMBER 2013
EUR ING. C ENG MSC. FWELDL

Professor John Norrish is an Emeritus Professor at UoW. Holding a Bachelor of Science in Metallurgy and Masters of Science in Welding Technology, Professor Norrish has more than 150 publications in refereed journals and international conferences and has received numerous awards including the International Institute of Welding E.O. Paton Prize for 'a lifetime of contribution to welding technology'. He is the author of 'Advanced Welding Processes', re-published several times by the Institute of Physics. Professor Norrish is a member of the steering committee of ITTC Naval Manufacture and Vice Chair of the International Institute of Welding Commission XII. He is Chair of the DMTC Ltd Research Advisory Panel.

Meetings attended: 5/6

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 AGM and Participant workshop was held on 6 November 2014. The workshop provided Participants with an update in relation to the Company's strategic plan, future contract discussions with the Commonwealth and likely future research activities.

The AGM was held immediately following the Participant workshop. Members provided unanimous endorsement of DMTC's strategic plan as well as current and planned research activity. Directors Mrs Bronwyn Constance, Dr Roger Lough and Dr Peter Jonson retired at the meeting in accordance with constitutional requirements and were subsequently re-elected to the Board of Directors. Mr Michael Grogan was appointed to the DMTC Board of Directors at the meeting.

Audit, Risk and Remuneration Committee

The Audit, Risk and Remuneration Committee is a formal subcommittee of the Board. The Committee was formed to assist the Board in its decisions on financial reporting and statutory audit functions, internal control structures, risk management, compliance and corporate governance. The Committee is comprised solely of non-executive Directors of DMTC, a majority of which are independent.

Research Advisory Panel

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

— Suggested areas of technology focus;

— Possible linkages across research expertise; and

— Ensuring research undertaken is of world class standing.

Defence Advisory Panel

The Defence Advisory Panel provides advice to the CEO in relation to Defence program structure and content to help ensure DMTC continues to address the priority technical concerns of Defence in respect to current and future planned activities. The Panel is comprised of representatives of DMTC and the Commonwealth.

GLOSSARY

ADA	Australian Defence Apparel
ADF	Australian Defence Force
AGM	Annual General Meeting
AiG	Australian Industry Group
ANSTO	Australian Nuclear Science and Technology Organisation
AOLP	automated off-line programming
ASSF	Advanced Surface Solutions Facility
BAE Systems	BAE Systems Australia Ltd
CASG	Capability, Acqusition & Sustainment Group
CDG	Capability Development Group
CI	Continuous Improvement
CRC	Cooperative Research Centre
CSIRO	Commonwealth Scientific and Industrial Research Organisation
Defence	Australian Defence Organisation
DIIC	Defence Industry Innovation Centre
DMD	direct metal deposition
DMO	Defence Materiel Organisation
DMTC	Defence Materials Technology Centre Ltd
DSTO	Defence Science and Technology Organisation
DST Group	Defence Science and Technology Group
ECAP	equal channel angular pressing
EHC	electroplating hard chrome
FY	financial year
HSR	high strain rate
HVOF	high velocity oxygen fuel
IED	improvised explosive device
IP	intellectual property
ISB	International Symposium on Ballistics
JSF	Joint Strike Fighter
MIC	microbiologically influenced corrosion
NAB	nickel aluminium bronze
PFC	personal fuel cell
PhD	Doctor of Philosophy
PZT	lead zirconate titanate
QUT	Queensland University of Technology
R&D	research and development
RMIT	Royal Melbourne Institute of Technology
SABO	South African Ballistics Organisation
SCC	selective phase corrosion
SCIP	Supplier Continuous Improvement Program
SHM	structural health monitoring
SLM	selective laser melting
SME	small to medium-sized enterprise
SUT	Swinburne University of Technology
Thales	Thales Australia
TIG	tungsten inert gas
UHHS	ultra high hardness steels
UoM	The University of Melbourne
UoW	University of Wollongong
UQ	The University of Queensland
UST	United Surface Technologies
VCAMM	Victorian Centre for Advanced Materials Manufacturing
Vipac	Vipac Engineers & Scientists Ltd

Please note that this report reflects a period of transition within Defence, and names of departments/groups vary accordingly to which applied at a particular point in time.

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