PROGRAM

Air

DMTC and its partners are working to build Australian industry capability to capitalise on new technology horizons across the air and space domains. The span of this effort covers new technology developments as well as advances in the use of existing additive manufacturing (AM) technologies and techniques.

DMTC and its government, industry and research partners have also been involved in extensive R&D efforts for over a decade to advance the use of AM in the sustainment and restoration of parts that are used, worn or damaged. Understanding the properties and performance of high-end, aerospace grade metals including ultra-high strength steels, titanium alloys and/or nickel alloys is vitally important.

This work aligns closely with Defence's identification of Sovereign Industrial Capability Priorities (or SICPs), one of which relates specifically to the maintenance of aerospace platforms. Documentation released by the Department of Defence in November 2020 specifically calls out *the design, development and repair of parts through additive manufacturing processes* as one of the underpinning industrial capabilities critical for Australia in this context.

Testing their mettle

DMTC is continuing to build on its research expertise and extensive collaboration with leading-edge industrial partners in areas of AM, with a particular focus on metallic AM methods such as wire arc additive manufacturing, cold spray deposition, laser powder bed fusion and new techniques such as atomic-diffused additive manufacturing.

While it is clear that AM and 3-D printing are not the answer to all questions, these methods are proving particularly useful in the development and manufacture of complex shape parts.

Taking research breakthroughs through to repeatable processes at an industrial scale - for new or repaired parts - continues to be a challenge in the adoption and acceptance of AM techniques.

As the maturity of the technology grows, the focus is shifting from experimenting with AM techniques to designing for AM. DMTC's involvement is helping to ensure that issues of quality, testing standards and accreditations are viewed through a Defence lens.

DMTC is working to support DSTG's ambitions around a rapid and robust certification pathway for all parts developed through the use of AM. This is being done by assessing the current level of capability in Australian industry and ensuring the availability of a high-quality, sovereign industrial base of Australian suppliers for use by Defence and the prime contractors.

DMTC is working with a range of Australian small businesses to manufacture challenging aerospace component designs using in-country industrial facilities.

The components produced by Australian industry are comprehensively evaluated by DMTC and DSTG using a combination of mechanical testing and microstructure evaluation. An important aspect of the project is that DSTG will also utilise their advanced in-situ process monitoring technology during part production – a critical element for fast-tracking AM component certification. This will provide deeper insights into the role of process parameters in determining component quality.

Opportunities abound

Many of the ADF's aircraft platforms are required to perform in harsh and demanding operating environments, including deployments at sea or high humidity tropics, and remain in service for as much as three or four decades.

This puts a premium on the work of DSTG, through DMTC and its partners, to understand, quantify and prevent a range of causes of damage and wear including corrosion and structural fatigue.

Of particular interest to Defence are cast magnesium alloys commonly found in flight-critical helicopter gearbox housings and components.

A better understanding of the corrosion performance of new anodised coatings applied to cast magnesium alloys – to protect them from corrosion – will directly inform planning for through-life support and sustainment management of Defence aerospace assets.

In a long-running research partnership with DSTG and the University of Queensland, DMTC is developing a deeper understanding of the corrosion behaviour of legacy and emerging magnesium alloys and coatings.

Recent work has involved comparisons of the corrosion resistance of a range of commercial anodised coatings. This work includes both short-term immersion testing in laboratories at UQ and longer-term, outdoor exposure testing of test samples in far north Queensland at DSTG's tropical exposure sites.

The DMTC project is also evaluating the performance of existing coatings and developing improved formulations for application as protective barriers on these magnesium components.

While the immediate application of this test and development work relates to alloys most commonly used in ADF rotary wing fleets (ARH Tiger, MRH-90 Taipan, MH-60R Seahawk, and CH-47F Chinook), there is significant potential for these investigations to inform the development of sustainment and through-life support plans for Australia's F-35 Joint Strike Fighter program, as well as other aerospace platforms.

This knowledge and understanding has also informed decisions by Defence's equipment acquisition programs, allowing for incorporation of improved technologies by the Original Equipment Manufacturers onto current and future aerospace platforms.

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PROGRAM

Geospatial & ISR

Expanding on Australia's world-leading expertise in instrument design and data analysis, these collaborative projects have supported the formation of Australian-led consortia with opportunities to create new sovereign Australian capabilities. Space is a critical domain for Australian technology, both for civilian or military applications. In a defence context, Australia's burgeoning interest in the Space domain has been likened to transitioning from frequent flyer membership to managing and operating an airline.

Against this backdrop, the Minister for Defence Industry recently confirmed that space-based technologies would be added to Defence's list of Sovereign Industrial Capability Priorities (or SICPs).

DMTC's work in this area since 2018 has focused on developing and demonstrating the capacity and expertise of Australian industry and research organisations to meet a growing demand for high-performance small satellite structures, componentry and data analysis. DMTC's industrial partners in this work reflect the predominance of small businesses and startups in the sector.

An example of the extension of these technologies to support national security agencies of Government, including but not limited to the Department of Defence, is DMTC's work with a small business delivering geospatial information and visualisation tools.

DMTC's project is coordinating a series of rapid technological development cycles to meet the requirements of Army and national intelligence community stakeholders. The project team is taking advantage of advances in image capture and synthesis of multiple 'feeds' of imagery to provide enhanced situational awareness capabilities.

Into low earth orbit

The successful launch of the M2 CubeSat in March 2021 marked the culmination of more than three years of preparation.

The CubeSat's imaging payload assembly (IPA) is mounted on a composite Ti-6Al-4V/Invar36 optical mount, produced by CSIRO as part of a DMTC project that successfully demonstrated a novel approach to accelerating the production of satellite components. The project used advanced manufacturing techniques such as 3-D printing and aerospace investment casting.

DMTC also collaborated with UNSW Canberra Space, CSIRO, La Trobe University and industry partner, A.W. Bell on a project to research, design, test and manufacture a CubeSat chassis and the optical mount.

More recently, the M2 mission achieved another major milestone with the spacecraft separating into two, while in orbit, to demonstrate formation flight and allow for further testing of intelligent, networked satellite technologies

A new angle on sovereign capability

DMTC also worked with University of Technology Sydney (UTS), Sydney-based industry partner, HyVista Corporation and specialists from DSTG on a compact, spatially agile spectral sensor (C-SASS) system.

The ability to tilt the view angle of the hyperspectral sensor and look 'off nadir' (at as much as a 40-60 degree angle) enables the image to be acquired without being directly above the target area, such as flying above the open ocean and looking towards a beach or coastal environment.

The team successfully developed a prototype and demonstrated its capacity during test flights in 2020. The more recent work, including support for a PhD candidature at UTS, has focused on interrogating the imagery using artificial intelligence (AI) and deep learning methods. These methods have allowed for the aggregation of both nadir and off-nadir imagery and validated an anomaly detection framework.

DMTC is also working with a project team involving researchers from the Australian National University (ANU), CSIRO and industry partner, Skykraft, a small business formed out of the UNSW Canberra Space team, on a CubeSat Hyperspectral Imager for Coastal Oceans (or CHICO).

CHICO is a visible light hyperspectral imager with defence, civil and research applications, for deployment in low earth orbit.

Deployed on a small satellite (SmallSat), the CHICO sensor could be tuned to measure optical water quality or detect objects in submerged environments, and simultaneously to provide a consolidated view of the targeted area.

The aim in both the C-SASS and CHICO projects is to provide customers, including Defence, with visibility of littoral environments (the land-sea boundary zone), with direct applications for navigation, disaster response, hydrographic survey and information gathering from denied or contested access areas.

Expanding on Australia's world-leading expertise in instrument design and data analysis, these projects have supported the formation of Australian-led consortia with opportunities to create new sovereign Australian capabilities.

Designing the systems to deploy on unmanned aerial vehicles and SmallSats puts an emphasis on making the systems compact in size without compromising the quality of data capture. Along the way the teams have confronted and overcome a number of technological barriers, including miniaturisation for deployment on target flight platforms, and size and weight optimisation of the prototype design.

The trade-offs between these competing elements have been addressed through advanced simulation techniques based on new design methods developed by the CHICO team in collaboration with DMTC.