Bigger problems demand better solution methods

The Defence problem space has expanded. The operating environment spans the cooperation-competition-confrontation-conflict spectrum and is multi-domain and multi-actor. The Australian Defence Force (ADF) seeks new warfighting advantages within this operating environment, and new operations analysis approaches are required to deal with this expanded problem space.

Background

The Defence Science and Technology (DST) Group sponsors research focused on high impact priority areas for future Defence capabilities. One such area is the Modelling Complex Warfighting (MCW) strategic research initiative, which was launched in 2017 with an initial five-year horizon.

Aim

MCW aims to revolutionise how DST undertakes operations analysis. We seek to provide warfighting advantages to the ADF through a superior ability to analyse:

- the complex interactions of geopolitical, social, technological, economic and cultural factors that characterise the operating environment
- the effectiveness of ADF response options within that operating environment, for both the conduct of current operations; and the design of the future force.[1]

These ADF response options are often required under high uncertainty, and without assumptions of predictability or system stability. These characteristics present significant challenges for operations analysis.

Impact

MCW is developing the transformational operational analysis capability to assure and accelerate decision-making by Australian Defence and Government on operations, future capabilities and investment.

1 *Force design is the planning and decision-making process regarding military equipment (capabilities) and future defence operations.*

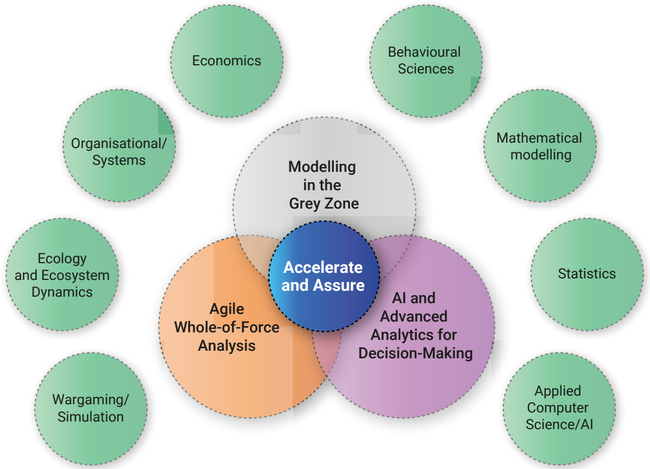
A new phase for Modelling Complex Warfighting

MCW is now moving into a new phase, signifying DST's increasing confidence and precision in MCW's pursuit of transformational operational analysis methodology; and transitioning from research exploration to consolidation to meet the expanded Defence problem space.

This new phase of MCW will create value for the ADF, and build significant operational analysis expertise equity to enhance all Defence and national security programs.

Central to this phase is the development of projects. Each project is designed to focus effort and collectively they will conduct the specific research required to provide transformational operational analysis to future force decisions. Each project is centred around grand challenges, which are designed to be:

- focused on critical Defence operational analysis problems
- aspirational with the potential to help Defence leap ahead
- inspiring to research partners



Project 1: Modelling in the grey zone

Grand challenge: The future is neither totally certain; nor totally uncertain. To what extent can we reduce apparently high future uncertainty through developing new theory, a lexicon and modelling approaches to anticipate, recognise, understand, interpret and respond to future events and dynamics?

Grey zone refers to the contemporary spectrum of conflict, where clear distinctions between peacetime and declared warfare are evaporating, replaced instead by a foggy continuum spanning cooperation-competition-confrontation-conflict.

This project proposes to generate a uniquely Australian intellectual edge by:

- defining the contours of the future operating environment
- developing a coherent theory of Defence problem-solving across domains in the grey zone
- specifically modelling grey zone activities and the impact of ADF actions to prevail in the grey zone

This project will link to DST STaR Shots[2] and proposes a *solution approach* of three broad lines-of-effort:

- pushing theoretical frontiers – responding to uncertainty
- reconceptualising the future operating environment
- developing and deploying grey zone modelling, simulation, experimentation and wargaming capabilities to inform operations and capability development

2 *https://www.dst.defence.gov.au/star-shots*

Project 2: Agile whole-of-force analysis

This project will generate an intellectual edge by transcending manual wargaming subjectivity; and providing the ADF's first definitive quantification of the decision-making trade-space in *capability* and *portfolio investment*.

Capability grand challenge: How can we capture multi-domain, multi-agent dynamics in a whole-of-force model?

MCW will inform the development of a multi-domain, multi-agent whole of force model for the ADF that is able to represent dynamics beyond simple 'red' and 'blue' adversarial kinetics. An inherent challenge is ascertaining an appropriate scale and level of abstraction for the whole of force model.

Portfolio investment grand challenge: What is the optimum future bundle of Defence capabilities (for a given budget) that maximises ADF warfighting advantage across a set of scenarios and acquisition timeframes?

MCW will target this wicked problem through three lines-of-effort:

- mathematical heuristics – pushing theoretical solution frontiers
- applied alternative solution frameworks
- benefits realisation framework – measuring value and success in Defence portfolio selection, under strategic, operational and tactical uncertainties

Collectively, this work will tackle the formidable numerical trade-offs of computational efficiency and solution quality at a portfolio level.

Project 3: Artificial intelligence and advanced analytics for decision-making

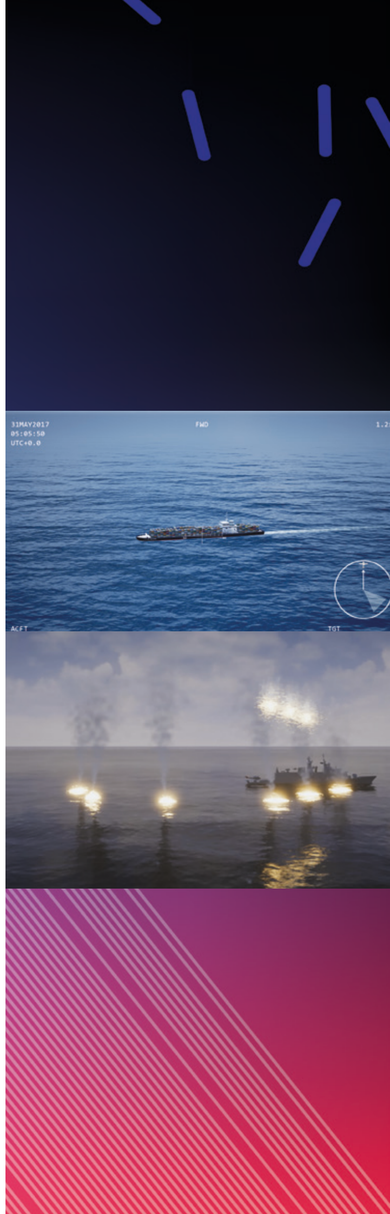
Grand challenge: What is the minimal human effort (expert and analyst) required to generate and test robust whole of force options, that fully integrates nested expertise across the ADF while preserving assured decision-making in the (human) senior hierarchy?

This project seeks to create a human-computer interface for ADF force design and testing. We are building our collaborative artificial intelligence (AI) capabilities as we transition to a trusted AI future. DST has identified several AI capability milestones to chart our progress towards this goal. Using the military appreciation process as a scaffold, these milestones include:

- AI can identify optimal tactics, given a force structure
- AI can suggest force structure options
- AI can suggest scheme of manoeuvre options (narrative construction)
- AI can provide coherent response options under conditions of complexity and uncertainty

These capabilities will be underpinned by investment in an advanced computing environment, which will support:

- the big data requirements to train AI
- plastic software architecture
- visualisation tools for decision-makers



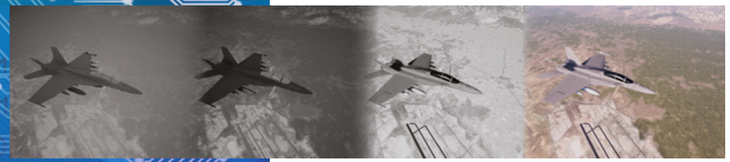
Operations analysis philosophy

To succeed, these ambitious projects must embrace a new operations analysis philosophy.

To identify new sources of ADF warfighting advantage, our operations analysis philosophy combines fit data, complex methods and a deliberately transdisciplinary approach.

Fit data means a capacity to work with both big data (when it is available), and also lean data scenarios. Complex methods refers to mathematics' ability to deal with more open, 'wicked' problem statements. A deliberately transdisciplinary approach searches for new and unique solution insights generated at the intersection of disciplines. This approach drives our collaboration with partners.

Our operations analysis philosophy of fit data, complex methods and a deliberately transdisciplinary approach will push the knowledge frontier outwards to deal with an expanded Defence problem space.



More, together: Partnering with us

This new phase of MCW also transitions our way of working with research partners.

- Future funding opportunities focused around specific grand challenge Defence problem statements.
- Deliberately transdisciplinary collaborative teams sought to achieve breakthroughs in operations analysis problem conceptualisation, methods and solutions.

Contacts

Modelling Complex Warfighting Lead

Dr Tim McKay
Joint and Operations Analysis Division
Defence Science and Technology Group
Department of Defence
tim.mckay@dst.defence.gov.au

Project Lead, Modelling in the grey zone

Dr Paul Gaertner
Joint and Operations Analysis Division
Defence Science and Technology Group
Department of Defence
paul.gaertner@dst.defence.gov.au

Project Lead, Agile whole-of-force analysis

Dr Yi Yue
Joint and Operations Analysis Division
Defence Science and Technology Group
Department of Defence
yi.yue@dst.defence.gov.au

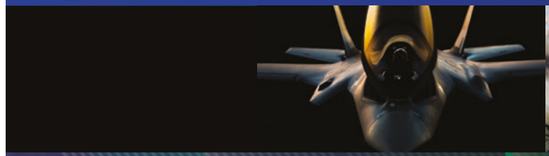
Project Lead, Artificial intelligence and advanced analytics for decision-making

Dr Jim Smelt
Joint and Operations Analysis Division
Defence Science and Technology Group
Department of Defence
jim.smelt@dst.defence.gov.au

Australian Government
Department of Defence

Modelling Complex Warfighting

Strategic Research Program



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