MODELLING COMPLEX WARFIGHTING

A modern Defence Force consists of a wide range of disparate capabilities, from infantry soldiers to cyber-attack. Selecting the best balance of these capabilities to assure national security is a challenging task that needs to take into account government objectives and budgetary resources, as well as analysis of likely future scenarios. This process relies increasingly on analytic tools such as modelling, simulation and optimisation techniques.

The Modelling Complex Warfighting (MCW) Strategic Research Initiative (SRI) seeks to revolutionise how we undertake operations analysis to better handle the interaction of complex geopolitical, social, technological, economic and cultural factors for design of the future force. The MCW SRI aims to address future defence force employment problems under four broad research themes: Conquering Uncertainty, Innovative Simulations, Knowledge Synthesis, and Modelling Complexity.

The MCW SRI is a five-year research initiative and is one of a portfolio of strategic research programs sponsored by the Chief Defence Scientist. This project has only just begun and you have a chance to be part of it. Active research topics include:

• Machine-discovered behaviour,

• Simulation for future operating concept development,

• Modelling complex human systems,

• Force effectiveness modelling,

• Concepts for complexity-enabled warfare,

• Data-driven operational analysis, and

• Modelling unknowns.

VANTAGE AND FUEL INFORMATION MANAGEMENT SYSTEM

Vantage is a long term research task developing decision support tools to risk-manage supply chain issues likely to compromise Defence's ability to conduct future contingencies. The current web-based software is focused on fuel and can assist in:

• generating optimal contract parameters,

• indicating the capacity of the current supply chain to support future capability; examination of fuel supply chain options,

• calculating fuel draw requirements, and

• visualising the effects of insufficient fuel throughput.

This software can be used in combination with Vital Planning and Analysis (VIPA) which is a logistics planning tool used by the Australian Defence Force.

The purpose of the Fuel Information Management System (FIMS) is to increase the visibility of the Defence Fuel Supply Chain operation. This is achieved by providing access to fuel related transactional data via data analysis and visualisation using the business intelligence tool Tableau. This allows Defence to make better decisions relating to demand drivers, inventory management and other supply chain drivers. There is scope to introduce more advanced data science techniques to further improve decision-making in areas such as supplier performance, supply chain resilience, supply chain risk and supply anomalies.
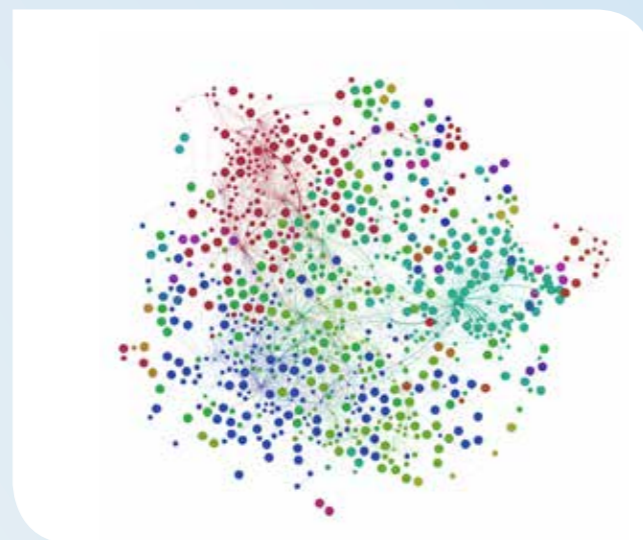
MARITIME EXPERT ELICITATION CAPABILITY ASSESSMENT TOOL

What are the key factors that contribute to or prevent the ADF achieving a specified military mission? Sometimes these factors can be modelled numerically, and sometimes not. As a first step we should always gather the experts and help them work through the issues together.

To address this question we need; a plan to achieve some primary mission effects, a task hierarchy which decomposes the mission, and a set of capability inputs or 'perspectives' for looking at the problem, such as training, or manning, or tactics.

The Research Imperatives

Subject matter experts begin by developing a shared understanding of the problem. They do this by generating and capturing their mission plan. Visual representations need to show what changes and when.

They then:

• **Ask** – Using an efficient and consistent data capture method the multiple experts can record their judgements using both words and numbers.

• **Seek** – With near real time aggregation and assessment of individual responses the whole group can argue, sort and prioritise the ideas into actionable information. This is where text mining, text summarisation, topic modelling and visualisations can come into play.

• **Critique** – The experts review each other's ideas in detail and in parallel, giving feedback as they go.

How can we do this efficiently and effectively? JOAD is interested in collaborative partnerships to improve our prototype facilitation web application called MEECAT.

WARGAMING

One of the division's key goals is to develop a capability that fosters wargaming, red-teaming and other analytical techniques through internal and external collaboration. This delivers enhanced understanding of force effectiveness and the contestability of whole-of-force assessments. JOAD has expertise in wargaming; including activity facilitation, design, tools and techniques and analysis.

Wargaming and red-teaming are useful techniques to explore the causes of success and failure on the battlefield and to determine military effectiveness through explicit consideration of the impacts of the environment, the enemy and capability inter-dependencies. Analytical wargaming, in particular, can be applied to define problems and conditions requiring detailed analysis, performance of systems in context and confirmation of results.

At SCINDICATE we have a Wargaming demonstration which consists of: a computer-based human-in-the loop model and an in-house designed paper-based wargame.

MASA-SWORD* is a computer-based wargame employed to develop and explore options for force structure studies and is also employed to generate planning data which can be used as inputs to computer-based combat simulations. The interactive example played at SCINDICATE shows a hypothetical battalion attack and demonstrates a range of current military capabilities.

* Paper-based wargames are designed to support seminar wargames and focus on decision-making and other human factors elements for the study of military concepts and trade-off options. The interactive game to be shown at SCINDIATE is based on a maritime/air problem at the platform level set in the Coral Sea.

STRATEGIC WARGAMING FOR FUTURE FORCE DESIGN

Wargaming is a powerful tool for exploration and assessment of options for the design of a modern defence force. The Headstart Matrix Game 2017 was a wargame set in 2035 that explored an intervention in, and stabilisation of, a small nation in South East Asia. The purpose of Headstart17 was to develop future force possibilities for the Australian Defence Force by addressing the question: "What effects might the Australian Defence Force encounter or need to employ in 2035?" Headstart17 was run in two phases; the first phase was a set of Plausible Futures Workshops to develop rich descriptions of a plausible range of alternative futures, and construct scenarios for wargaming. In the second phase, matrix-style wargames explored possible future military effects to inform the development of future operating concepts and force design.

Successful wargames create rich, immersive experiences for the players, which allow them to apply their experience and judgement in a new context.

JOAD is interested in collaborative partnerships to improve wargaming capability using technology such as virtual and augmented reality and interactive communication media. There may also be partnership opportunities for broader strategic analysis methodologies including portfolio selection and optimisation, futures analysis and trade-off analysis.

MICROSOFT HOLOLENS

JOAD conducts Operations Research to support acquisition and capability enhancement of ADF platforms and related systems. The work is supported by a range of modelling and simulation tools that are used primarily for scenario-based mission level analysis across all roles.

Researchers are exploring the application of Augmented Reality/Virtual Reality (AR/VR) technology for collaborative Air Combat scenario development, visualisation and analysis. They have developed a number of prototype systems to evaluate emerging technologies, including working with the RAAF Plan JERICHO team on a prototype AR system for mission rehearsal and replay. The team is working with a number of universities using AR/VR to support research into the representation of complex behaviours in Air Combat modelling and simulation tools.

The challenge is to find an application that value-adds by providing an immersive, collaborative environment that facilitates more effective planning and analysis of air combat. Examples of suitable applications may be: the visualisation of complex scenarios with large numbers of integrated components, and scenarios with complex environments that are difficult to conceptualise, such as Electronic Warfare environments.

Joint and Operations Analysis Division

Wargaming for the Future Force

DST's Joint and Operations Analysis Division (JOAD) undertakes rigorous, scientifically-based analysis of Defence operations and capability to provide independent, impartial, timely advice. This advice allows the Australian Defence Force (ADF) to optimally exploit its equipment and personnel and provide Australia with the best possible war-fighting capability.

The division applies its knowledge to contribute significantly to the development of future capability through support to the evolution of joint concepts, future force structure, capability development for individual services, and opportunities to leverage disruptive technologies.

Further information
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DST Science and Technology for Safeguarding Australia