Partnering with Joint and Operations Analysis Division

DR Brian Hanlon – a/Chief JOAD
Major Science & Technology Capabilities

- Maritime Mathematical Science
- Maritime Simulation, Experimentation & War-gaming
- Maritime Systems Analysis
- Australian Maritime Warfare Centre

Maritime Capability Analysis

- Joint Warfare Mathematical Science
- Joint Organisation & Social Science
- Joint Simulation, Experimentation & War-gaming
- Defence Systems Integration
- Defence Operations Support Centre
- Scientific Adviser CJOPS

Joint Capability Analysis

- Land Mathematical Science
- Land Organisation & Management Science
- Land Simulation, Experimentation & War-gaming

Land Capability Analysis

- Strategic Analysis
- Force Design
- Technology Forecasting & Futures
- Strategic Security Risk Assessment

Strategic Capability Analysis

- Aerospace Mathematical Science
- Aerospace Organisation & Management Science
- Aerospace Simulation, Experimentation & War-gaming
- Aerospace Systems Analysis

Aerospace Capability Analysis

- Planning and Logistics
- Situation Assessment
- Command Intent
- Behaviour and Control

Decision Sciences

Trusted Autonomy, Behavior, Complexity and Control

Principal Scientist
Joint & Operations Analysis Division – Partnering Highlights

• Signed a collaborative research funding and review program with U.S. AFOSR in May.
• Partnered with RMIT to develop an advanced Helicopter Aircrew Training System assessment tool.
• Partnering with USAF Headquarters A9, AFRL, US Navy (NAVAIR) and Australian academia (University of Melbourne and RMIT University) to develop the next generation air combat modelling and simulation
• Invitational Symposium on Trusted Autonomous Systems (ISTAS) with world-class national universities and international academic and Defence partners in May.
100
Agreements
Last 5 years

45
Research Agreements
Last 5 years

14
Types of Agreements
Last 5 years

31
External Parties
Last 5 years

8.3 mil
Total Budget
Last 5 years

2 business days
Average Sign off time for CJOAD
Last 1 year

10 business days
Average Sign off time for External Parties
Last 1 year

Budget ($) for each Executed Agreement
2015-16

Budget ($) for each Executed Agreement
2014-15

MSTC Agreement Distribution

MSTC Budget ($) Distribution

Average Sign off time for External Parties
Last 1 year

Budget ($) and Agreement Distribution
Joint & Operations Analysis Division – Partnering Opportunities

- Operations Analysis
- Capability Analysis
- Wargaming
- Complex System Evaluation
- Visualisation
- Machine Learning
- Autonomy
- Technology Futures

To support the S&T Acquisition within Defence, the future force, along with the force-in-being, and S&T Support to Operations.
DR Dale Quinn
a/RL Aerospace Capability Analysis

INTEGRATED AEROSPACE OPERATIONS
The Changing Face of Australian Air Power

- Joint Strike Fighter F-35 Lightning II
- P-8
- F/A-18F Super Hornet
- ARH Tiger
- Wedgetail AEW&C
- MRH-90
- C-17 Globemaster
- KC30B Multi-Role Tanker Transport
- C-27J
A strong, strategic centre to strengthen accountability and top level decision-making

Plan Jericho is Air Force’s plan to transform into a fully integrated force that is capable of fighting and winning in the information age.
Opportunities for Collaboration

Advanced Metrics
Advanced Methodologies
Multi-Resolution Modelling
Advanced Visualisation
DR Jim Smelt
RL Maritime Capability Analysis
MARITIME CAPABILITY ANALYSIS
MARITIME CAPABILITY ANALYSIS

Uses the techniques of operations research and analysis (mathematical modelling, simulation, experimentation, wargaming, systems analysis, data analytics) to support evidence-based decisions on Navy’s Force structure, warfighting concepts, acquisition of systems, operational effectiveness and capability management.
Enhancing Current Capability

DST Group Activity

- Operations/Exercise Analysis
  - Data collection
  - Reconstruction
  - Analysis
  - Reporting
- Fleet Trials and Experimentation
- Warfare Modelling
- C2 Modelling and Analysis
- Warfighting Assessments
  - structured qualitative assessments of the ability of ADF to achieve warfighting effects

Navy Outcome

Enhanced Operational Effectiveness through

- Benchmarked capability
  - identify gaps
  - accept into service
- Knowledge of effectiveness
  - Force
  - C2 System
- Evidence for new requirements
- Evolved tactics for new threats
- Optimised processes, organisation and manning
Creating and Shaping the Future Force – Strategy and Concepts Phase

Conduct maritime force analysis and maritime experimentation to provide

- Future concept development, exploration and testing leading to future task group operating concepts
- Analysis of options for the Future Maritime Force to inform Defence’s Force Design process
Creating and Shaping the Future Force
- Risk Mitigation, Requirement Setting & Acquisition Phases

Support Maritime Capability Acquisition
- Analysis to generate requirements
- Analysis and evaluation of options
Maritime Capability Analysis - Partnership Opportunities

- Support improvement in scope, flexibility and responsiveness of our modelling and simulation toolbox
- Research and develop expert elicitation tools to improve accuracy and efficiency of interactions with the warfighter
- Assistance with options for better capture, storage, management and exploitation of exercise and operational data
- Provide specialist training for research staff in new tools and techniques
- Student placements/internships, e.g.
  - Data analytics
  - Simulation
  - Mathematical modelling
DR Lin Zhang
a/Research Leader Land Capability Analysis

LAND CAPABILITY ANALYSIS
Land Capability Analysis: Modelling combined arms close combat

Close combat is Army's core capability. Success in close combat depends on having the right mix of elements in the Combined Arms Team in the fight.

This research will advance modelling and simulation of Land Close Combat in order to better understand the contributions made by elements of the Combined Arms Teams to close combat effectiveness; ensuring that Army has the required mix of capabilities to succeed at close combat into the future.

Partnership Opportunities

- Statistical design of experiments
- Simulation input data generation and representation
- Simulation scenario development and representation
- Simulation based data analytics
- Human in the loop simulation
- Simulation software development
This research goal aims to develop operational effectiveness models, tools and techniques that provide a clear understanding of how various land combat enablers including situational understanding, C3 and combat support, as well as joint enablers, impact the operational effectiveness of the reinforced combat brigade engaged in joint land manoeuvre.

The effectiveness of ground manoeuvre warfare depends on effective and balanced combat enablers.

LCA: Evaluating the impact of ground combat enablers

Partnership Opportunities:

- Mathematical modelling and optimisation
- Statistical experiment design
- Data mining and predictive analysis
- Systems modelling and component modelling
- Inferential statistics
LCA: Developing holistic analytical approaches to shape future army

Army, as a complex socio-technical organisation operating in complex environments, cannot be fully evaluated exclusively through reductionist analytical approaches. This research goal aims to develop holistic evidence-based approaches that enable understanding, analysis and assessment of the performance of the whole of the land force operating in an irreducibly uncertain and complex future.

The expected outcome of this research is to provide contestable whole of force evidence to support Army in the design and development of a robust and adaptive 'future-proofed' force for joint interagency land operations.

Partnership Opportunities:

- Systems thinking analysis
- Conceptual modelling
- Problem structuring
- Knowledge elicitation
LCA: Establishing Land Analytical Wargaming Capability

Analytical wargaming is an important tool for understanding the complexity of modern warfare that is centred around the competitive interactions of key elements within a flexible warfighting framework. This research goal aims to establish a wargaming capability that fosters the development of wargaming analytical models and techniques through internal and external collaboration.

This research will leverage JOAD's war-fighting domain knowledge and access to privileged Defence information, partnered with related industry and academic expertise.

The expected outcome of this research will develop tools and methods that will enhance the understanding of land and joint force effectiveness and so contribute to future-proofing the ADF and enhance the contestability of whole-of-force evidence based assessments.

Partnership Opportunities:

- Methodology development for wargaming
- Red teaming and seminar wargaming tools and techniques
- Use of analytical wargames in military experimentation
- Scenario construction and analysis
DR Richard Davis and DR Nigel McGinty

STRATEGIC CAPABILITY ANALYSIS
Opportunities for Collaboration:

Technology Forecasting

- Development of methods for robust future technology forecasting.

Force Design

- Complex Systems Evaluation.
- Advanced visualisation.
Strategic Force Design
Force Design: underpinning the new Capability Life Cycle

DST Group role – robust evidence based analysis to support decision making

Integrated Investment Program

The Capability Streams

- Force Design is now central to:
  - Integrated Investment Program
  - The CLC and Contestability
  - The Capability Streams

6 x Streams:
- Intelligence, Surveillance, Reconnaissance, Space, Electronic Warfare and Cyber
- Air and Sea Lift
- Land Combat and Amphibious Warfare
- Strike and Air Combat
- Maritime and Anti-Submarine Warfare
- Key Enablers
Strategic Force Design

Collaboration opportunities
- capability analysis
- whole-of-force design modelling
- prioritisation and resource allocation
- complex systems evaluation
- cost and benefit-cost investment analysis
- multi-dimensional visualisation

Our centre of gravity
Technology Foresighting and Futures
Provide input to and guidance across Defence on:
- Avoiding strategic surprise
- Future Operating Environments
- Inform Investment decisions

A systematic process of analysis to describe requirements for emergence of and prospective impact of a technology; to develop insight into possible future technological capabilities and their attributes in relevant scenarios.

**Partnership Opportunities:**
- **Universities** – EDTAS, methodologies & technology assessments.
- **Industry** – EDTAS & technology assessments
- **Academy of Sciences**: Joint Foresight Assessments

**TW/HS products** (EDT Toolkit and List)

- **Input to research & planning**
- **Input to operational programs**

**Identification & Capture**
Leverage TW/HS tools & approaches (EMR)

**Scientific Assessment**
Leverage SMEs across disciplines (burden-sharing)

**Contextualisation & Prioritisation**
Leverage Impact Assessments to cover additional topic

**Emerging & Disruptive Trends**
Leverage common formats to produce sharable results
EDTAS 2015 – Trusted Autonomy

- **Objective:** to understand and shape the long term vision for Trusted Autonomous Systems to influence national dialogue and guide longer term investments by Defence.

- **Focus:** on Trusted Autonomous Systems to support humanitarian assistance and disaster relief (HADR).

- Partnered with UNSW & Noetic Group to deliver the event.

- **Strengths of the symposium:** Senior and strategic focus, interactive and multi-disciplinary approach to a specific technology sector.
EDTAS 2017

The theme for EDTAS 2017 will be:

**Information, Knowledge and Digital Disruption**

- Future topics will consider:
  - Biotechnologies
  - Future Manufacturing and Advanced Materials

- We are seeking event partners to host the event and develop program.
  - academic and industry partners are being sought.
DR Duncan Craig

RL Joint Capability Analysis

“JOINT FORCE INTEGRATION BY DESIGN”
Joint Force Capability and the Capability Life Cycle

Implications of the First Principles Review

S&T support to VCDF Group:
- Joint Concept development, experimentation and refinement
- Joint Capability Management and Integration

Achieving ‘program-level’ joint force integration
- Items and measures that can be used to explore and assess the suitability of capability integration options
- Systems Science: System-of-systems engineering techniques / C4ISR architecture frameworks
- Federated simulation environments to support joint experimentation (includes support to Committee decision making)

Engagement with the industry and the international community [INCOSE 2017]
Joint Force Operations – anticipating the future

Learning Lessons
Operational Evaluation

Understanding Emerging
Operational Risks
Technology Forecasting
& Red Teaming

• Data mining and filtering
• Lessons analysis
• Organisational learning techniques (to help exploit the value of lessons learned)
• Links to the DST Group technology Divisions
• Risk analysis techniques
• Modeling and Simulation tools
Joint Force Operations - urgent S&T support to current operations

Mission

To enhance ADF operational effectiveness and mitigate operational risk.

Figures (15 years)

- 121 operations analysts within deployed HQs
- 166 on ‘Fly Away Teams’ for specific field studies
- 11 embedded specialist S&T staff
- 165 Operational Urgent S&T Projects conducted
Joint Capability Analysis - Partnership Opportunities

- Research and development of system-of-systems techniques and tools that can support the CLC / achievement of Joint Force by Design
- Development and application of organisational psychology techniques in support of culture change that enables “Joint” / leverages lessons learned
- Research and develop expert elicitation tools tailored to ‘program-level’ capability integration
- Assistance with options for better capture, storage, management and exploitation of exercise and operational data
- Simulation environments that support decision making in the joint capability arena
DR Jason Scholz
Program Tyche Lead

PROGRAM TYCHE –
TRUSTED AUTONOMOUS SYSTEMS
STRATEGIC RESEARCH INITIATIVE
Trusted Autonomous Systems

- Started 1 July 2015
- Moving to a ‘Defence CRC’ model soon
- Aims to place DST Group and Partners in the World’s Top Five in trusted autonomous systems (TAS) in 7 years
- Focused research question
- Smooth a path for industry and transition to Defence
- Defence White Paper NGT Funded
Australia has developed World-Class Autonomous Systems

Port Botany container handing fully automated from April 2015. (ACFR, University of Sydney, Patricks)

Rio Tinto ‘Mine of the Future’ Autonomous drills, trucks, train. (ACFR, Rio Tinto)
Defence Autonomous Systems


DSTO scientist and Project Director, Dr Jackie Craig, led the Australian R&D team.

ScanEagles 2007-2012 in AFN, flew 6,200 missions 32,000hrs

Shadow 200 deployed from March 2012

RAAF Heron 2010-2012 AFN. Since 2012 used for training prior to introduction of MQ-4C Triton
US Third Offset Strategy

- Adversaries are developing their own ISR-strike networks—with emphasis on missile systems—to challenge conventional US power projection

- Global Surveillance and Strike (GSS) network
  - UAV and UUV emphasis with submarines, stealthy deep strike, hypersonics, cyber
  - Persistent operation in denied areas (wide area, long range)
  - Access to Space degraded or denied (ISR, Communications, GPS), ships too vulnerable
  - Human-on-the-loop, minimal manned platform exposure

- “Premium on survivable forward presence” and global responsiveness”
Research Themes

**Autonomy**
Philosophical and mathematical bases for dealing with uncertainty;
Significantly reduce exposure to harmful consequences;
Guaranteed to not exceed boundary conditions; new means to certify for ADF use.

**Resilience**

**Cognitive**
Fast reactive and simultaneous slow logical “thinking”;
Machine high-level fusion, planning and intent subject to uncertainty;
Large scale control of machines; Machine-machine interaction and tasking.

**Machines**

**Trustworthy**
Interacting hybrid teams more effective than human-only teams;
Understand organisation changes required to acquire and operate;
Trust of machines; Mission Command of machines.

**Partners**

**Embodied**
Evolutionary robotic design;
Multi-modal perception and control;
Lifetime learning and evolution of systems;

**Intelligence**
TTCP Autonomy Strategic Challenge

Littoral: Base protection, Critical infrastructure protection, Counter-smuggling

- 2016 C2 Systems Trials (US, UK, AS)
- 2017 Platform Autonomy Trials (US, UK, CA, NZ)
- 2018 “Autonomous Warrior” Trial (AS Nov)

Objectives

- Human “on the loop” control of multiple simultaneous UxV missions
- Machine-learned plans
- Minimal operator interaction
- Autonomous systems that assess intent by probing / interaction
- Littoral threats and unknowns (manned & unmanned)
Examples

**Academic Impact**

- New mathematical foundations
  - Non-ergodic strategies
- New machine cognition
  - Machine learning
- New human-autonomous systems interaction
- Novel autonomous systems
  - UUV glider, Novel sensors & control

**Defence-Industry Impact**

- **3rd Offset Strategy capabilities**
- Theatre Anti-Submarine Warfare
- Autonomous Ops in Urban Environments
- **5th Generation Command & Intelligence Systems**
- Autonomous distribution: warehouse to foxhole
Summary

- TAS program seeks game changers for warfare
- Scoping a Defence CRC in Trusted Autonomous Systems
- Comprehensive new program
- Get involved from the beginning
- Your opportunity to shape a “Defence CRC” model in this area
Joint and Operations Analysis Division Contacts

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