Force Expansion Curves
a way to model future capability

James Ong
Defence Systems Analysis Division
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<th>3. DATES COVERED</th>
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<td>Defence Science and Technology Organisation, Defence Systems Analysis Division Australia</td>
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<th>13. SUPPLEMENTARY NOTES</th>
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<tr>
<td>See also ADM001929. Proceedings, Held in Sydney, Australia on July 8-10, 2003., The original document contains color images.</td>
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Standard Form 298 (Rev. 8-98)
Prepared by ANSI Z39-18
Other authors

- Andrew Nicholls, Office of the Minister for Defence
- David Cox, Air Operations Division
- Richard Bartholomeusz, Air Vehicles Division
Structure of talk

- How does the ADF manage capability?
- What are Force Expansion Curves?
- Case study: Maritime Patrol Group
- How can we use Force Expansion Curves?
How does the ADF manage capability?
What are Force Expansion Curves?
Motivating example
Motivating example

Capability

Warning Time
Motivating example
Motivating example

Capability

Warning Time
Motivating example

Capability

Warning Time

Preparation
Military context

Capability

Current capability

Warning Time

Req 1

Req 2

Req 3
Military context

Capability

Derived planning guidance

Work-up period to address capability deficiency

Warning Time

Req 1

Req 2

Req 3
Key questions

- How do we measure capability?
- How do we interpret strategic guidance?
  - Hard constraints (optimisation)
  - Soft constraints (goal programming)
- How do we create Force Expansion Curves?
Case study: Maritime Patrol Group
Case study: Maritime Patrol Group

- In 2000, DSTO study of preparedness recommends the development of Force Expansion Curves
- Maritime Patrol Group was chosen:
  - Continuity
  - Good data
  - Enthusiasm and support
General approach

- Simulate the crew training and posting cycle

Why did we break this up into two parts?

- Test the feasibility of the resulting flying program
Variables and parameters

- Capability measure: Number of crews
- Variables (controls):
  - Capacity of simulators
  - Number of instructors
  - Recruitment
  - Course lengths and posting lengths
EXTEND

- Simulation environment
- Both continuous time and discrete event models
- Features:
  - Good graphical user interface
  - Hierarchical blocks
  - Monte Carlo simulation
  - Sensitivity analysis
  - Heuristic optimisation (genetic algorithm)
  - Compatible with MS Excel
Personnel Model

- Personnel pipelines modelled as a production line
  - People modelled as items
  - Events modelled as machines
- Current and future MPG personnel practices are included
Personnel Model

Airborne Electronic Analysts

292 Squadron

Operational Squadrons

AEA Posting Decision

Ground Posting

Operational Airborne

AEs

instruct/standards

operational support

project duties

Airborne Electronics

Wedgetail

sergeants with
minimal flight exp

new flight
sergeants

sergeants

sergeants with
sensor training

sergeants

recruits

sergeants

recruits

sergeants

new flight

experienced

flight sergeants

experienced

flight sergeants

experienced

flight sergeants

experienced

flight sergeants

experienced

flight sergeants

experienced flight sergeantsexperienced flight sergeants

Wedgetail

Airborne Electronics

Airborne

Electronics
Personnel Model

- Crew:
  - 2 Pilots
  - 2 Navigators
  - 1 Airborne Electronics
  - 5 Airborne Electronic Analysts
  - 2 Flight Engineers
Personnel Model

- Each role has a separate module
  - Easily understood and validated
  - Caters to time limitations
- Roles combine into crews
- Other modules:
  - Initialisation
  - Controls
  - Outputs
Personnel Model

- Predicts future crew levels
  - Baseline: current personnel practices
  - ‘What if’ analysis: altered system
- Indicates critical factors and bottlenecks
Sample Personnel Results

Sample crew expansion curves

- Baseline
- More AEA insta
Sample Personnel Results

Airborne Electronics

Crews
**ASTOR**

**Air Force Simulation of Tactics and Operational Resources**

- Developed by the Swedish Air Force and the RAAF
- Used by MPG to manage P-3C logistics
- Tests a predetermined flying program for feasibility
- **Constraints:**
  - Maintenance crews
  - Maintenance equipment
  - Spare parts
  - Aircraft reliability
ASTOR

- Outputs:
  - Aircraft availability
  - Proportion of missions accomplished
  - Spare parts consumption
  - Repair and maintenance time
Sample ASTOR results

MISSIONS ACCOMPLISHED
Missions accomplished, fraction of ordered

Fraction in %

Missions cancelled
Missions with < max no. of a/c
Missions with max no. of a/c

FS  FS-Dep  MSI  NS  Other SUR-BUT  SUR-Dep  TAC-BEV  SUM
Using ASTOR to Support the Personnel Model

Implies cannot meet flying program
How can we use Force Expansion Curves?
Assistance to medium term preparedness planning
Assistance to medium term preparedness planning

Capability

Pm

Pm

Unachievable

Strategic/Capability Imbalance
*Strategic excess or Capability deficiency*

Strategic/Capability Alignment

Strategic/Capability Imbalance
*Strategic deficiency or Capability excess*

Po

Current Capability

Pm

Maximum Achievable Capability

Warning Time
Conclusions

- Force Expansion Curves can improve capability management by:
  - Illustrating different expansion strategies
  - Demonstrating rate and extent of expansion
  - Quantifying the effect of controls
  - Allowing costing of different options