Decision support for RCN crewing: 
Simulation for Crew Optimization and Risk Evaluation (SCORE)

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RCN crewing

- Royal Canadian Navy (RCN) is in the midst of several major capital acquisitions: Joint Support Ship, Arctic Offshore Patrol Ship, Canadian Surface Combatant
- Crew size and composition are key contributors to each platform’s operational effectiveness

Crew Validation

Options Analysis

Crew Generation
Right size crew

- US Naval Research Advisory Committee (2000) reported that Total Ownership Cost (TOC) of naval ships is:
  - 30% procurement, 70% operations and support (O&S)
  - Of O&S costs, 51% is personnel
- US General Accounting Office (2003) reported that milestone decisions made in development phase determines 80-90% of TOC
- Early research on Optimized Crewing focussed on reduced or minimum Manning
- Risks with too-large and too-small crew estimates
  - Design and Build;
  - Design changes, policy/procedural changes, refits, operational impact
S&T support to crewing analysis

- Identify / expose factors relevant to crewing analysis
- Support users in *explicitly* defining and combining relevant factors
  - e.g., Single-threat vs. multi-threat warfare
  - e.g., Preventive vs. corrective-only maintenance
  - e.g., Baseline vs. Increased automation
- Support users in *systematically* evaluating and comparing impact
  - e.g., crew utilization, crew resource conflicts
SCORE Crew Validation (2012-present)

**Inputs:**
- Scenarios (missions, capabilities)
- Roles (given technologies, policies, procedures)
- Crew (number, occupations, ranks)

**Analysis:**
- Crew Validation (role-crew assignments)
- Options Analysis

**Outputs:**
- Crew Usage
- Crew Conflicts
SCORE Crew Generation (2013 to present)

**Inputs:**
- Organizational Demands (roles, qualifications)
- Watchkeeping Demands (roles, qualifications)
- Capability Demands (sets of concurrent activities)

**Analysis:**
- Evolution Demands (roles, qualifications)
- Maintenance Demands (qualifications, hours required)

**Outputs:**
- Crew Validation
- Options Analysis
- Crew Generation
- Crew size (NOTIONAL)
- Crew composition
SCORE: Sample inputs for crew generation
SCORE: Key outputs and observations

- Lowest and highest usage among crew
- Average daily usage
- Per crew member: roles filled, time per role
  - Appropriate resource allocation?
  - Implications for training or procedures?
- Comparison: Roles with higher or lower usage
  - Appropriate prioritization (e.g., for class of ship? mission?)
- Comparison: Roles with zero usage
  - Critical? (e.g., mission)
  - Second-order effects (e.g., force generation)?
Iterative analysis vs. Crew optimization

- Conflict resolution – which ones and how? command decision?
- Technologies – undecided, unfamiliar
- Concept of operations – undefined, evolving
- Policies and procedures – undefined, evolving
- Force employment vs. Force generation, force development
- Min size, Min rank, Min cost - data available? accessible?
- Max utilization or Min conflicts – desirable?

Ongoing tradeoffs

Navy expertise, Navy priorities

“Best” vs. Informed Decision

External climate
SCORE Crew Validation predicts crew conflicts, crew utilization

Crew utilization is a coarse and incomplete measure of crew performance in sustained operations

- indicators of potential issues – crew members, scenario segments
- But, what are acceptable limits for utilization?
- What are cumulative effects of over-, under-, or acceptable utilization?

Approach: Integrate crew performance model into Navy crewing decision support tool

DRDC Fatigue Model (DFM) (Ali, Bouak & Peng, 2011)
SCORE + DFM: Sample output

Summary of Predicted Effectiveness – sample crew, sample scenario
Future work

- Automated decision support
  - automated scenario generation, sources of uncertainty, support for simulation experiments

- Integration of crew performance model
  - Sleep & fatigue, other performance factors

- Model validation
  - Scientific literature, allied research, simulator studies or sea trials

- Model applications
  - Different class ships, ashore or command organizations
Summary

- SCORE is designed as decision support for direct use by RCN personnel.
- SCORE supports multiple phases of crewing analysis, as ship acquisition projects evolve.
- Capabilities continue to be added, tested, applied, and improved in SCORE.
- RCN used SCORE to re-evaluate baseline crew for the Canadian Patrol Frigate.
- SCORE is being applied across multiple ship projects.
The RCN & SCORE

Lieutenant-Commander Ramona Burke
Director Naval Personnel & Training 5-3: Future Fleet
14 November 2014
RCN Crewing Methodology

To determine crew composition for RCN vessels in the future fleet several factors are taken into consideration:

- Extant regulations:
  - External: IMO, SOLAS, Canada Shipping Act
  - Internal: Ship-borne Helicopter Ops (SHOPS), Ship’s Standing Orders (SSOs))
- Concept of Employment/Concept of Operations for the ship class
- An assessment of equipment manpower/monitoring requirements
- Comparisons with CCG/Allied crew sizes for vessels of similar size and capability
- Consultation with stakeholders and military occupation managers
- Results of studies by independent consultants
- Modelling and simulation using SCORE
The SCORE Advantage

SCORE significantly reduced time that would have been spent on trial and error with various crew sizes and compositions by:

- Allowing for the creation of one scenario, to be used multiple times
- Generating usage reports to more easily identify personnel that were overtasked in the Watch and Station Bill
- Generating conflict reports that more easily identified personnel who had multiple assignments during concurrent evolutions
- Identifying unassigned roles or gaps in personnel for specific evolutions
- Calculating the hours of departmental work being conducted by various crew sizes for comparison purposes