NATO Independent Cost Estimating & Capability Portfolio Analysis

Naval Center for Cost Analysis
Brian Flynn
DoDCAS 2008
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• Background
  – NATO
  – Task Groups
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• Recommendations
• Road Ahead
  – Brochure
  – ICEs
  – Portfolio Analysis
Introduction

• OSD CAIG vision
  – Improve cost estimating in the international defense community
    • 2004 start

• Follow-on to previous efforts
  – Generic Life Cycle Cost Breakdown Structure (GCBS)
“The Parties of NATO agree that an armed attack against one or more of them … shall be considered an attack against them all.”
## NATO Membership

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<th>Belgium</th>
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<td>Latvia</td>
<td>United States</td>
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NATO Expansion

Military Highlights

- 1954 … Soviet Union tries to join
- 1994 … first military action; Bosnia
- 1999 … Kosovo War; Yugoslavian leader Slobodan Milosevic captured
- 2003 … NATO takes command of the International Security Assistance Force (ISAF) in Afghanistan
NATO Research

- Task group on cost analysis created and approved by NATO’s Research and Technology Organization
- Mission of RTO

“To support the development and effective use of national defence R&T and thus to maintain a technological lead within the Alliance;

To meet the military needs of the Alliance;

To provide advice to NATO and national decision makers.
RTO Role

North Atlantic Council

NC3A
NATO Consultation, Command and Control Agency

MC
Military Committee

CNAD
Conference of National Armament Directors

Science Committee

ACT
Allied Command Transformation

ACO
Allied Command Operations

RTO

NIAG
NATO Industrial Advisory Group

Main Armament Groups

NAAG

NNAG

NAFAG

Research and Technology Board (57)
Panel Members (373)
Scientists and Engineers (3,500)
RTA Headquarters (61)
Every Task Group needs a TAP (Technical Activity Proposal) and a TOR (Terms of Reference)
Cost Analysis

SAS-028; Cost Breakdown Structure for NATO
2003

SAS-054; Methods and Models for Life Cycle Costing.
Lead: Mr. Marcel Smit
2004 to 2006

AC/327 Working Group on Life-Cycle Costs

SAS-069; Brochure of best practices.
Lead: Mr. Marcel Smit

SAS-076; ICES and Portfolio Analysis
Lead: Brian Flynn
SAS-054

• Membership
  – NATO and Partnership for Peace (PfP) nations invited
  – Participants
    • Denmark, Germany, Norway, Switzerland (PfP), United Kingdom, France, The Netherlands, Sweden (PfP), Turkey, United States, OCCAR
  – Observers
    • Belgium, Italy, Greece, Georgia (PfP)

Organisation conjointe de coopération en matière d'armement
• Partnership for Peace alliance aims to create trust between NATO and other European states and the former Soviet Union
  – Created in 1994
  – 23 members
• Objectives
  – Understand NATO and PfP nations’ methods and models for cost analysis
  
  – Promulgate best practices within NATO’s Phased Armaments Programming System (PAPS)

Lead: Mr. Marcel Smit, The Netherlands

Executive Secretary (Chief of Staff): Mr. Arthur Griffiths, United Kingdom
**Method**

- Each nation asked to map its acquisition process into PAPS
- Then, *best practices* in cost analysis identified for each phase
- U.S. mapping:

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<thead>
<tr>
<th>PAPS PHASES in LIFE CYCLE</th>
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<th>3</th>
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<tbody>
<tr>
<td>Mission need evaluation phase</td>
<td>Pre-feasibility phase</td>
<td>Feasibility phase</td>
<td>Project definition phase</td>
<td>Design and Development phase</td>
<td>Production phase</td>
<td>In-service phase</td>
<td>Disposal phase</td>
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Pre System Acquisition

- Concept Refinement
- Technology Development

System Acquisition

- System Develop. & Demonstration
- Production & Deployment

Sustainment

- Operations & Support
- Included in O&S

**User Needs & Technology Opportunities**

- Process entry at Milestone A, B, or C
- Entrance criteria met before entering phase
- Evolutionary Acquisition or Single Step to Full Capability

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<thead>
<tr>
<th>Concept Refinement</th>
<th>Technology Development</th>
<th>System Development &amp; Demonstration</th>
<th>Production &amp; Deployment</th>
<th>Operations &amp; Support</th>
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<td>Program Initiation</td>
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**Pre-Systems Acquisition**

- Concept Decision

**Systems Acquisition**

- Design Readiness Review
- LRIP/OT&E

**Sustainment**

- FRP Decision Review
- Operations & Support
Findings

• Data Collection
  – Critical but difficult for all nations
  – Availability of data often defines what methods and models can be applied

• Methods and Models
  – Standard estimation tools like OLS are common

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<tr>
<th>Models</th>
<th>Mission need</th>
<th>Pre-feasibility</th>
<th>Feasibility</th>
<th>Project Definition</th>
<th>Design &amp; Developm.</th>
<th>Production</th>
<th>In-service</th>
<th>Disengagement</th>
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Legend
- blank: No nation
- 1 nation
- 2-3 nations
- >3 nations
Findings

• Risk and Uncertainty
  – Life cycle cost estimates are widely regarded as probability distributions
  • Point estimate merely one observation

  – Sensitivity analysis and use of SMEs common

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<th>Risk</th>
<th>Mission need</th>
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<th>Feasibility</th>
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Legend:  
- blank: No data  
- 1 nation  
- 2-3 nations  
- >3 nations
Findings

• Presentation of Results
  – Little standardization within or between nations
  – Essential to convey the “right” information cogently

• Exchange of Information
  – Significant barriers
  – Difficulty in accessing each others’ websites and databases

“the basic problem,” from PARC
Recommendations

- Life cycle cost estimates should:
  - Be fully documented
  - Be prepared by experienced personnel
  - Include an affordability analysis
  - Use cross-checks

- Life cycle cost models should:
  - Be validated by a recognized testing process

- Data collection efforts should:
  - Focus on cost, programmatic, technical, and performance information
    - Within the entire NATO/PfP community
    - To improve the accuracy, visibility, and availability of data *useful to all*

Breakdown barriers on information access
Recommendations

- Risk and uncertainty analysis should be based on one or more generally accepted techniques such as
  - Sensitivity analysis
  - Monte Carlo simulation
  - Garvey’s scenario-based analysis
  - U.K.’s risk registers
- Risk and uncertainty analysis should start early
  - With analytical justification of values
  - Don’t leave to the 11th hour

Develop early, with each point estimate
Recommendations

• Conduct Monte Carlo simulation along these lines
  – Generate a baseline estimate that reflects uncertainty
    • “Noise” or variance in estimating relationships
  – Then include risk
  – Delta between the means is cost risk

See work of Mr. Tim Anderson and AFCAA’s CRUH for more details
Recommendations

- Convey to decision makers the *essential* fact that cost estimates are *stochastic*
  - List assumptions or describe scenarios

<table>
<thead>
<tr>
<th>Low Estimate</th>
<th>Baseline Estimate</th>
<th>High Estimate</th>
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<tbody>
<tr>
<td>585M</td>
<td>715M</td>
<td>895M</td>
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<tr>
<td>500M</td>
<td>600M</td>
<td>900M</td>
</tr>
</tbody>
</table>

> Low-end historical cost growth factor of 18%
> Baseline estimate
> Historical cost growth factor of 25%

Cost Growth Factor, Sensitivity Analysis, or Risk Register from the UK

> 40th percentile estimate using Monte Carlo simulation
> Mean estimate using Monte Carlo simulation
> 80th percentile estimate using Monte Carlo simulation

Risk and Uncertainty Analysis Using Monte Carlo Simulation

> X month schedule
> Y month schedule
> Z month schedule
> > 80% learning curve
> > 85% learning curve
> > 90% learning curve
> > 65% commonality with predecessor
> > 60% commonality with predecessor
> > 20% commonality with predecessor
> > Business base strong
> > Business base solid
> > Business base weak
> > Moderate inflation
> > Accelerating inflation rate

Underlying Assumptions or Scenarios

Display a range of estimates
• Code of Practice for Life Cycle Costing
  – Describes best practices for all phases of the life cycle
    • Examples
    • Handy booklet
  – End date: Sep 2008
• NATO Independent Cost Estimating and Capability Portfolio Analysis
  – New effort
    • Start: June 2008
    • End: June 2011
  – ICEs
    • Proof of concept for SAS-054 guideline
  – Role of cost estimating in capability portfolio analysis

Lead: The United States
**Candidate ICEs**
- Ex-post testing
  - One or more systems where a CARD/MDAL is available
    - Test against actuals
- New systems
  - To support decision making

A400M
• Capability portfolio analysis
  – Best practices
  – Two or three international conferences
    • Subject matter experts from each nation
      – E.g., Joint Staff, USD(AT&L), SOCOM HQ in the U.S.
  – Emphasis on role played by life cycle cost analysis

“In defense planning, capability is defined as the enduring ability to generate a desired operational outcome or effect, and is relative to the threat, physical environment, and contributions of coalition partners.” [Through Life Capability Management Conference, London, 2007]
NATO Forces

• Long-term goal of NATO cost-analysis activities
  – Engender more informed resource decision making within the Alliance to support coalition warfighters

NATO forces in Afghanistan
Backup
• Examples of *initial* efforts in executing capability portfolio analysis
  – NCCA’s pilot in mine warfare
  – Joint staff example
**MCM Portfolio**

**Strategic Assets**
- National Reconnaissance Office - Satellites
- National Geospatial-Intelligence Agency - Digital maps
- Defense Intelligence Agency - Human intelligence
- Air Force B-52s and strike aircraft
- Navy P-3s

**Dedicated Navy Assets**

**Surface**
- Two classes
  - MCM-1 Class
  - MHC-51 Class
- Command ship (High Speed Vessel Swift)
- Systems such as SQO-32, -32 (HFWB), SLQ-37, and SLQ-38

**Airborne**
- 20 MH-53E Sea Dragons (multi-purpose)
  - Systems such as AQS-14, AQS-20, AQS-20A, AQS-24
  - Mk-103 to Mk-106

**Undersea**
- Explosive Ordnance Disposal (EOD)
- Divers
- Marine mammals

**Organic Navy Assets**

**Surface**
- Littoral Combat Ship
  - Unmanned Surface Vehicle (USV) with influence sweep
  - Vertical Take-off Unmanned Aerial Vehicle with COBRA
  - MH-60S (see below)
  - Remote Minehunting System
  - NSCT-1 with SCULPIN

**Airborne**
- MH-60S Knighthawk with
  - Underwater towed array (AQS-20A)
  - Airborne Laser Mine Detection System
  - Airborne Mine Neutralization System
  - Rapid Airborne Mine Clearance System
  - Organic Airborne & Surface Influence Sweep

**Undersea**
- UUVs; MRUUV

**Command**
- Systems such as SYQ-13 & MEDAL

**Assault**
- Systems such as ABV & JDAM

**Research and Development Program**
- DARPA
- ONR - Future Naval Capability
- Naval Surface Weapons Center - Carderock and Panama City
- Basic & applied research; technology demonstration
Design of Scoring

• Strategy-to-systems model for MCM assets

Identification and Ranking of Strategic Tasks

Operational to Strategic Tasks

Tactical to Operational Tasks

Systems to Tactical Tasks
  -- Effectiveness
  -- Risk

Tied to National Defense Strategy and Presidential Directives

Effectiveness -- Risk
Value of Systems

Detection, Localization, Classification, and Identification of Sea Mines

Numbers shown are sample ROIs

ROI = Military Value/Cost

Each bubble captures development and procurement costs over the FYDP + ten years’ O&S cost (in FY06$)

Note: ROI is shown only for systems with complete cost data
Concept Decision: (To-Be)

To Be:
- Aligned
- Capability Orientation
- Open Aperture
- Joint
- Broad Range of Options
- “Best Practice” emphasis

Strategic Choice of Portfolio Options with Requirements, Acquisition, & Programming Stakeholders Represented

Future Focus Here

Portfolio Analysis

Incremental Development

Stronger Emphasis

Technology Development—TRL/IRL

MRL

Science and Technology Base
• Next two slides were briefed to DEPSECDEF, Vice Chairman JCS, and other members of the DAWG

• Based on required capabilities to support a notional MCO or stability operation
### Example Capabilities: Operational Plan Assessment  
(What & How Much)

<table>
<thead>
<tr>
<th>Tier 1 JCA / Tier 2 JCA</th>
<th>Effect 1 AQ and Affiliates are denied safe havens, freedom of movement and funding to establish new footholds (H)</th>
<th>Effect 2 Friendly nations defeat terrorist threats within their borders (I)</th>
<th>Effect 3 Terrorists cannot acquire or employ WMD/E (I)</th>
<th>Effect 4 COCOM is able to recover and eliminate uncoordinated WMD/E materials and maintain the capacity to conduct consequence management in the AOR (I)</th>
<th>Effect 5 Terrorist organizations are unable to conduct attacks against U.S. homeland and interests (I)</th>
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**Legend:**
- **X** Sufficiency
- **X** Gap
- **X** Overage
Notional Example

**Example Implementation / Execution:** Who and How (Tasks & Activities) Solution Trades

<table>
<thead>
<tr>
<th>Capability Provider</th>
<th>Tactical Aircraft</th>
<th>Inventory</th>
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</table>

- Exploring the solution space:
  - Evaluate On-Hand Capability
  - Evaluate alternatives to fill gap:
    - Increase current capability—buy more airframes
    - Substitute alternatives
    - Change DOT_LP
    - Accept Risk
  - Present decision makers with options in terms of risk and resources
  - Execute a decision

*(Notional Example addressing a Joint Air Operations, Tactical Air Gap)*