

In Process

**Modeling of Life Cycle /
Operations & Support Costs**
To what degree is commonality achievable?

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**Prepared by
Life Cycle Cost Modeling Subcommittee
Modeling and Simulation Committee
Systems Engineering Division
National Defense Industrial Association**

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Life Cycle Cost Modeling Subcommittee Charter

- **Assess the degree to which Life Cycle Cost (LCC) Models, but more particularly, Operations and Support (O&S) Cost Models, can achieve more commonality**
 - Include both modeling tools and supporting data
 - Consider commonality both within similar system classes (e.g., aircraft), and across different system classes
- **Focus on cost modeling for new systems, and for upgrades to existing systems, early in the acquisition process**
 - Consider factors that affect cost model accuracy at this stage

Life Cycle Cost Modeling Subcommittee Membership

- **Chris Price (Raytheon), Subcommittee Chair**
- **Danielle Anderson (Raytheon)**
- **Rick Cline (Boeing)**
- **Jim Coolahan (JHU/APL), M&S Committee Chair**
- **Jerry Cothran (Lockheed Martin)**
- **Phil Fahringer (Lockheed Martin)**
- **Charlie Stirk (CostVision)**
- **Andreas Tolk (Old Dominion University)**

Presentation Outline

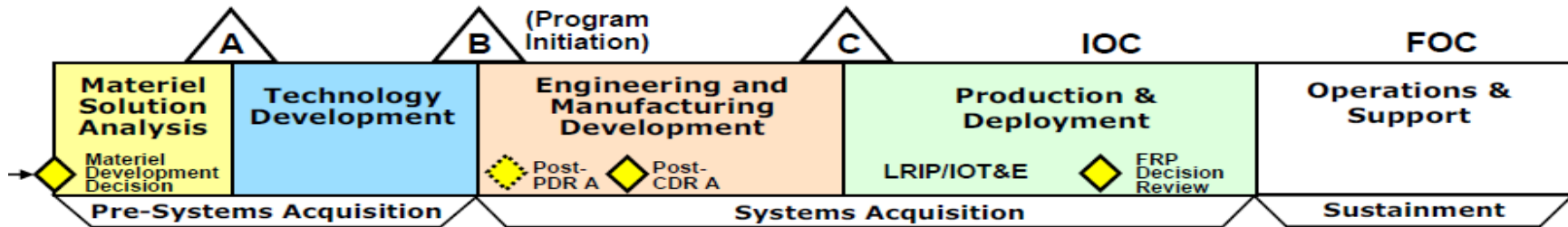
- **Background**
- **Cost Definitions (TOC, LCC, O&S)**
- **How O&S Modeling Is Done Now**
 - Tools, Data
- **Some Data on LCC/O&S Cost Overruns**
- **Why Might Cost Estimates Be “Biased Low”?**
- **Commonalities and Differences in O&S Cost Structures**
 - Within and Across Platform/System Types
- **To What Degree Can LCC/O&S Cost Models Be Common?**

Background

- The Department of Defense (DOD) spends billions of dollars each year to sustain its weapon systems. These operating and support (O&S) costs can account for a significant portion of a system's total life-cycle costs ...
- DOD lacks key information needed to effectively manage and reduce O&S costs for most of the weapon systems GAO reviewed—including life-cycle O&S cost estimates and complete historical data on actual O&S costs. The services did not have life-

GAO-10-717 'DoD needs better Info. & Guidance to Reduce O&S' July 2010

DoD Standard LCC Definitions



DoD 5000.4-M Life Cycle Cost



DAG Section 3.1 Total Ownership Cost (including Indirect / Infrastructure Costs)



JCIDS Manual Ownership Cost (including Indirect / Infrastructure Costs)

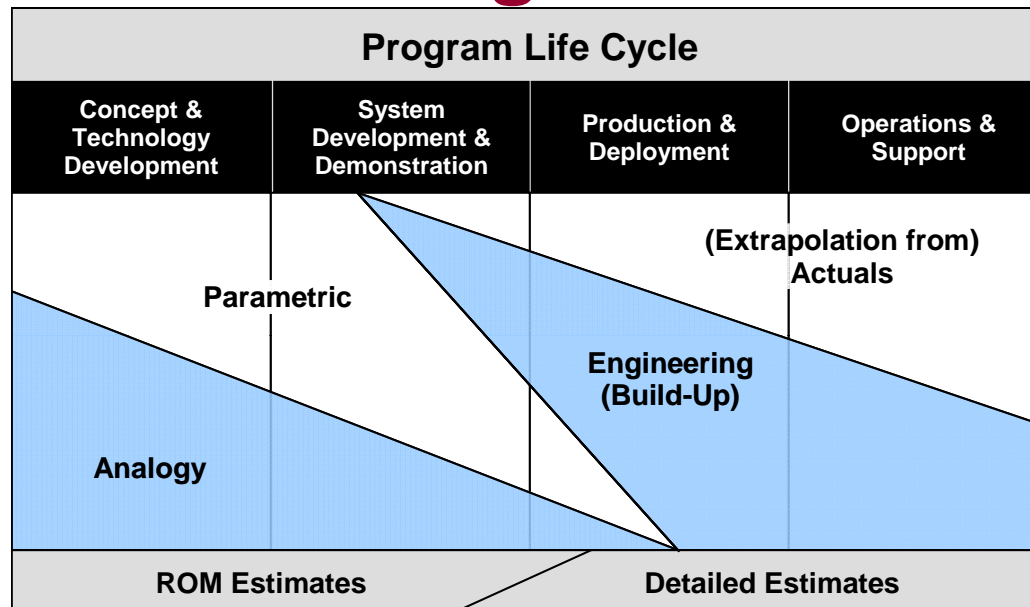


How is O&S modeling done now? — Tool Summary*

- **Total LCC Estimating Tools**
 - O&S is a subset
- **O&S Estimating Tools**
 - Direct operating costs only
 - Manpower costs only
 - Software costs only
 - Combinations of above: generally, no single tool does it all
- **Source**
 - 3rd party
 - Homegrown

(*See back of this presentation / back-up for results of Tool Survey)

How is O&S modeling done now? — Data



Defense Systems Management College, 2001 (Chart #300R4)

- **O&S Modeling input data dependent on where in Life Cycle the O&S estimate is being generated**
 - More analogous and parametric early in life cycle
 - More bottoms-up and extrapolated actuals later in life cycle
- **Technical/programmatic descriptions**
 - System thru Component definitions
 - Ops & support concepts
- **Historical/reference data (Service/Contractor)**
 - Service VAMOSOC instantiations
 - Other R & M data (e.g. REMIS)

O&S overrun data, with sources

CNA Study reviewed 15 ship programs and 11 Aviation programs with the following general and specific findings^{1,2,3}:

- O&S cost growth problem has been a persistent issue
- Average “growth” from initial O&S cost estimate to latest estimate is 15 percent

Breakdown by Program Type	All programs	Ships	Aircraft
O&S delta	15% (1.9%)	6% (0.8%)	27% (3.1%)
Personnel delta	17% (2.1%)	21% (2.7%)	13% (1.6%)
O&M delta	19% (2.3%)	1% (0.1%)	42% (4.5%)

1. Average is not weighted by size of the program—that causes some distortion when looking at particular O&S component by program type
2. Numbers in parentheses are average annual cost growth
3. All figures are adjusted for inflation, flight hours, and number of aircraft per squadron as appropriate

Three Programs (F/A-18 E/F, MH-60S, SSN-774) examined in detail identified common causes that explain the majority of the cost increases:

- Increasing requirements
- Incorrect price forecasts -notably additional MEHRC costs and AVDLR and consumables cost increases above inflation
- Accounting changes that allocate more of the indirect costs to platforms - notably additional BOS costs

Overall, the following recommendations were provided:

- Use CERs more often in generation of (*initial*) O&S cost estimates
- Develop standard reporting structure
- Examine whether “official” inflation forecasts systematically underestimate actuals

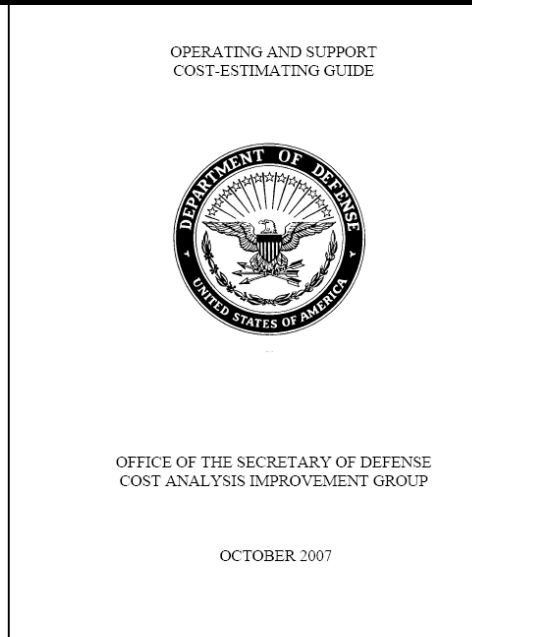
Information on this slide extracted from
www.ncca.navy.mil/doncas/briefings/2009-Choi.ppt

Why Might O&S Estimates be Biased Low?

- **System acquisition assumptions**
 - VAMOSOC system inaccurate/incomplete (GAO-10-717)
 - Baseline estimates based on peace-time OPTEMPO (anecdotal)
 - O&S cost estimates are the ‘red-headed stepchild’ (GAO-10-717, GAO-10-257, GAO-03-57, etc.)
 - Decisions made on poor/incomplete analysis (GAO-09-41)
- **Failure to re-baseline**
 - Program design changes (e.g. Qty, SDB and MRAP)
 - Weapon system design changes (C-17, M1A1, etc.)
 - Maintenance concept changes (e.g. C-17, GAO-10-717)
- **Potpourri**
 - Wrong metrics (total program O&S costs, not \$/flthr or \$/sqdn, etc.)
 - Growing sustainment burden over time (Dunnigan, *How to Make War*, 4th Ed)
 - Changing support/distribution concepts (USAWC Strategy Research Project, Operation Iraqi Freedom and Logistics Transformation)

Commonalities/Differences in O&S Structures Across Platform/Systems

O&S Estimating Guide



Operating & Support Cost Structure

- 1.0 Unit Personnel
 - 1.1 Operations Personnel
 - 1.2 Maintenance Personnel
 - 1.3 Other Direct Support Personnel
- 2.0 Unit Operations
 - 2.1 Operating Material
 - 2.2 Support Services
 - 2.3 Temporary Duty
- 3.0 Maintenance
 - 3.1 Organizational Maintenance & Support
 - 3.2 Intermediate Maintenance
 - 3.3 Depot Maintenance
- 4.0 Sustaining Support
 - 4.1 System Specific Training
 - 4.2 Support Equipment Replacement
 - 4.3 Operating Equipment Replacement
 - 4.4 Sustaining Engineering & Program Management
 - 4.5 Other Sustaining Support (e.g. Special Test Req'ts)
- 5.0 Continuing System Improvements
 - 5.1 Hardware Modifications
 - 5.2 Software Maintenance & Modifications
- 6.0 Indirect Support
 - 6.1 Installation Support
 - 6.2 Personnel Support
 - 6.3 General Training & Education

- "...authoritative source for the collection of reliable and consistent historical O&S cost data..."
- Applicable to all Services and all system domains
- This WBS is directed at the 3rd level

- Differences manifest themselves at the 4th level
- Work needed for a WBS element not coded (eg. repair vs replace)
- Need common codes to ensure cost data is homogenous for analysis

The OSD O&S Cost Estimating Structure

1. Unit-Level Manpower

- 1.1 Operations
- 1.2 Unit-Level Maintenance
- 1.3 Other Unit-Level

2. Unit Operations

- 2.1 Operating Material
- 2.2 Support Services
- 2.3 Temporary Duty

3. Maintenance

- 3.1 Organizational Maintenance
- 3.2 Intermediate Maintenance
- 3.3 Depot Maintenance

4. Sustaining Support

- 4.1 System Specific Training
- 4.2 Support Equipment Replacement
- 4.3 Sustaining Engineering and Program Management
- 4.4 Other Sustaining Support

5. Continuing System Improvements

- 5.1 Hardware Modifications or Modernization
- 5.2 Software Maintenance and Modifications

6. Indirect Support

- 6.1 Installation Support
- 6.2 Personnel Support
 - 6.2.1 Personnel Administration (Personnel Acquisition, Individuals Overhead Accounts)
 - 6.2.2 Personnel Benefits (Family Housing, Commissaries, Child & Family Support, DoD Schools)
 - 6.2.3 Medical Support
- 6.3 General Training and Education
 - 6.3.1 Basic & Initial Skill Training
 - 6.3.2 Educational Activities

Source: Operating and Support Cost-Estimating Guide, Office of the Secretary of Defense Cost Analysis Improvement Group, October 2007

To What Degree Can LCC Models be Common?

- **Support Standards and Specifications**
 - ISO 10303-239 Product Life Cycle Support (PLCS)
 - Integrated Logistics Specifications (in development by ASD/AIA from Europe/US)
 - » S2000M Material Management
 - » S3000L Logistics Support Analysis
 - » S4000M Scheduled Maintenance Analysis
 - » S5000F Operational and Maintenance Data Feedback
 - Extensions to EVMS for Programs of Record as applicable to Acquisition Cost (NDIA Project Management and DCMA)
 - Pursue improvements to the VAMOSOC system for O&S Cost accumulation
- **Define a common schema**
 - Possible integration of cost into FEA and DODAF
- **Standardize Models to the maximum extent possible**

To What Degree Can LCC Models be Common (cont.)?

- **Very few models currently exist that calculate both Acquisition & O&S Costs well**
- **Acquisition Cost Models are largely dependent on Platform / System Product Structures**
 - Since all platforms / systems are different (re: MIL-HDBK-881A – Eight – Soon 12 System types), all Acquisition Cost Models are different
- **However, development of a Super O&S Model is technically achievable**
 - Development of a Super O&S Model will require significant resources
 - Considerations need to be given to differing Service level procedures and Maintenance Concepts, and other WBS differences identified here-in

Super O&S Model Basis

Based on preliminary analyses of current / existing cost models / tools, we believe that the models shown here can be used as a basis for construction of a 'Best of Breed' Super O&S Cost Model

Raytheon LCC Tool Study,
Dec, 2010

Source Model / Tool	Cost Output / Algorithm
CASA	- repair labor and material - support equipment maintenance - training - SW mod and maintenance
VAMOSC	- repair labor and material - government labor - operations manpower - SW mod and maintenance - support services
MAAP	- operations manpower
PRICE	- repair labor
Blanchard	- other unit-level manpower
MOSS	- other unit-level manpower - training munitions and expendable stores
FEMP	- electricity cost
METEOR	- government labor - indirect ownership
AMCOS	- indirect ownership
AFTOC	- operator training - other operational material - Hardware modification and modernization
OSCAM	- training - repair material - other operational material - hardware modification and modernization
LCCA	- support and operating equipment maintenance - other sustaining support
SEER IT	- other sustaining support
DISA	- other sustaining support
SEER SEM	- SW mod and maintenance
COCOMO	- SW mod and maintenance

Back-up

Life Cycle Cost

- **C3.3.7. Life-Cycle Cost.** Life-Cycle Cost includes ALL WBS elements; ALL affected appropriations; and encompasses the costs, both contractor and in house effort, as well as existing assets to be used, for all cost categories. It is the TOTAL cost to the Government for a program over its full life, and includes the cost of research and development, investment in mission and support equipment (hardware and software), initial inventories, training, data, facilities, etc., and the operating, support, and, where applicable, demilitarization, detoxification, or long term waste storage.

DoD 5000.4-M – Cost Analysis Guidance and Procedures

(All cost elements – **excluding** indirect / infrastructure costs: can apply to a system, product, or even a component)

2/18/2011

Ownership Cost

- (b) Mandatory KSA (**Ownership Cost**): Ownership Cost provides balance to the sustainment solution by ensuring that the operations and support (O&S) costs associated with materiel readiness are considered in making decisions. For consistency and to capitalize on existing efforts in this area, the Cost Analysis Improvement Group O&S Cost Estimating Structure will be used in support of this KSA. Only the following cost elements are required: 2.0 Unit Operations (2.1.1 (only) Energy (fuel, petroleum, oil, lubricants, electricity)); 3.0 Maintenance (All); 4.0 Sustaining Support (All except 4.1, System Specific Training); 5.0 Continuing System Improvements (All). Costs are to be included regardless of funding source. The KSA value should cover the planned lifecycle timeframe, consistent with the timeframe used in the Materiel Availability KPP...

CJCSM 3170.01C - Chairman of the Joint Chiefs of Staff Manual (JCIDS)

(Basis for Carter Sustainment Quad – O&S Costs, including indirect / infrastructure – no Acquisition costs)

2/18/2011

Total Ownership Cost

- ***“total ownership cost consists of the elements of a program's Lifecycle cost, as well as other infrastructure or business processes costs not necessarily attributable to the program. Infrastructure is used here in the broadest possible sense, and consists of all military department and defense agency activities that sustain the military forces assigned to the combatant and component commanders. Major categories of infrastructure are support to equipment (acquisition and central logistics activities), support to military personnel (non-unit central training, personnel administration and benefits, and medical care), and support to military bases (installations and communications/information infrastructure).”***

Defense Acquisition Guidebook: Excerpt from 3.1

(All cost elements – **including** indirect / infrastructure costs)

2/18/2011

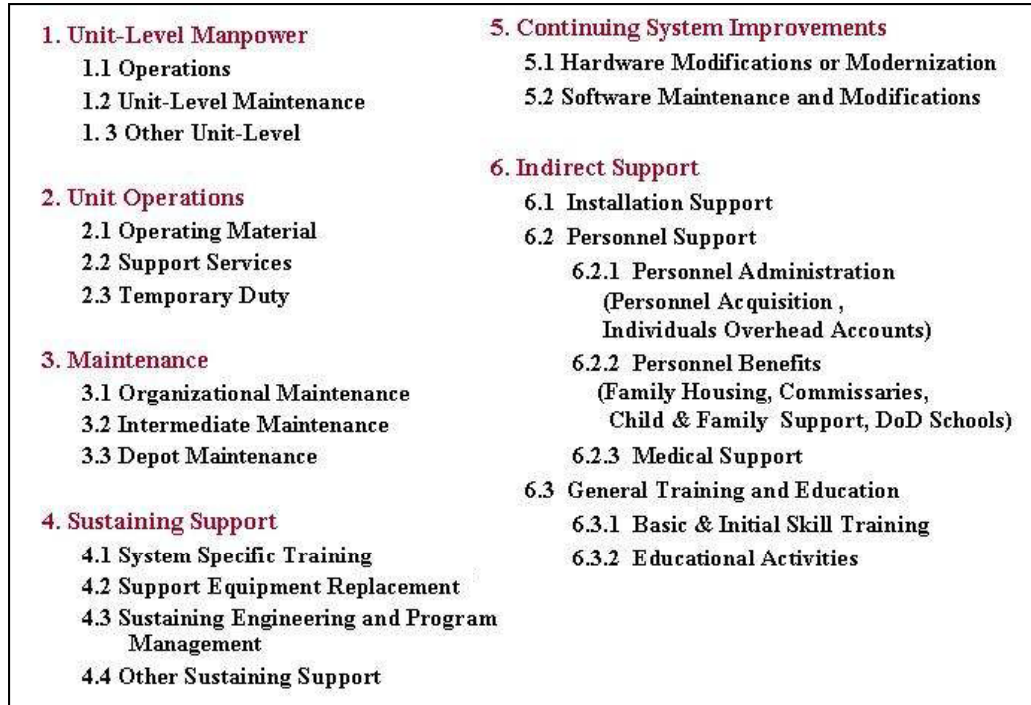
How is O&S Modeling Done Now? – Selected Tools

O&S Cost Estimation Tools*



*Sample of tools surveyed

OSD O&S Cost Estimating Structure



Source: Operating and Support Cost-Estimating Guide, Office of the Secretary of Defense Cost Analysis Improvement Group, October 2007

The OSD O&S WBS provides a good standard for O&S Cost Estimation, but effectively none of the tools surveyed estimate to this WBS

Commonalities/Differences in O&S Structures Across Platform/Systems Cont.

MCR CRITICAL THINKING. SOLUTIONS DELIVERED.

Integrating Program Acquisition Requirements

- Generated by Government
- Identifies Work to be Performed

SOO/SOW

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WBS

- Ties System Definition with Work to be Performed
- Conforms to MIL-HDBK
- Framework for Technical, Cost, Schedule Reporting

MCR CRITICAL THINKING. SOLUTIONS DELIVERED.

Progress to Date

- Established focus groups to update WBS and definitions for all appendices and add new appendices
 - Government and industry participation includes Program Offices, Systems/Software Engineers, Cost Estimating and EVM communities
 - Systems/Appendices Addressed
 - Aircraft Systems
 - AIS/ERP Systems (new appendix)
 - Electronic Systems including embedded SW (adding templates: Processors, EW, Radar, Comm, Nav/Guide)
 - Missile Systems
 - Launch Vehicles (new appendix)
 - Space Systems
 - Unmanned Aircraft Systems
 - Sea Systems
 - Unmanned Sea Systems (new appendix)
 - Ordnance Systems
 - Surface Vehicle Systems
 - Propulsion Systems (new addendum)
 - Construction (new appendix)
 - Common Elements
 - System of Systems (new addendum)