Life Cycle Costing and Its Relationship to T&E

W. C. (Dev) Devers
Institute for Defense Analyses
Cost Analysis and Research Division
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Overview

• DoD Acquisition Process: DoD 5000 Series
• Role of Cost Analysis in supporting the acquisition process and programs Life Cycle
• Where T&E and Cost Analysis Are Linked in the Acquisition Process and life cycle analysis
• Estimating T&E Costs
• Assessing the Effects of T&E Results on LCC
• Data Sources
DoD Acquisition Policy

• Primary objective:
  – Acquire quality products that satisfy the needs of the operational user with measurable improvements to mission accomplishment, in a timely manner, at a fair and reasonable price.

• Policies and principles are divided into three major categories:
  – (1) Translating Operational Needs into Stable, Affordable Programs,
  – (2) Acquiring Quality Products, and
  – (3) Organizing for Efficiency and Effectiveness.
DoD Acquisition Phases and Milestones

Phases and milestone decision points

• Facilitate the orderly translation of broadly stated mission needs into system-specific performance requirements and a stable design that can be produced efficiently.

• Low Rate Initial Production (LRIP) may occur during Phase II if so decided at Milestone II (see DoD 5000.2R part 1.4.4.1)
Four Major Milestone Decision Points and
Four Phases of the DoD Acquisition Process
ACQUISITION PHASES AND MILESTONE DECISION POINTS

OVERALL ACQUISITION STRATEGY

PHASE

MILESTONE

PHASE

MILESTONE

WHERE ARE WE?
- Baseline
- Cost
- Schedule
- Performance
- Execution Status

WHERE ARE WE GOING?
- Program Plans
- Exit Criteria

WHAT RISKS EXIST?
- Cost
- Schedule
- Performance

WHERE ARE WE?
- Refined Baseline
- Cost
- Schedule
- Performance
- Execution Status

WHERE ARE WE GOING?
- Program Plans
- Exit Criteria

WHAT RISKS EXIST?
- Cost
- Schedule
- Performance

RISK MANAGEMENT
Role of the Program Manager in the DoD Acquisition Process

- Establish key cost, schedule, and performance parameters;
- Document key parameters in an Acquisition Program Baseline;
- Develop an acquisition strategy, which addresses
  - potential sources,
  - risk management,
  - Cost as an Independent Variable (CAIV), contract approach, and
  - management approach.
- Develop a test and evaluation strategy that describes the salient elements of the test program and complies with all statutory requirements regarding testing.
- Develop a life-cycle cost estimate for the program.
Cost As an Independent Variable

• Objectives
  – Provide the customer/warfighter with highly capable systems that are affordable over the life cycle and
  – establish balance between cost, schedule and performance early in the acquisition process and to manage to the cost objective.

• Potential Metrics
  – Unit Recurring Production Cost (dominate)
  – Unit Life Cycle Cost
Test and Evaluation (T&E)

• Process by which a system or components are compared against requirements and specifications through testing.
• Results are evaluated to assess progress of design, performance, supportability, etc.
  – Developmental test and evaluation is an engineering tool used to reduce risk throughout the defense acquisition cycle
  – Operational test and evaluation is the actual or simulated employment, by typical users, of a system under realistic operational conditions.
Purpose of T&E

- Fundamental purpose - identify the areas of risk to be reduced or eliminated.
- Roles during phases of development,
  - Early Phases (DT&E)
    - concerned chiefly with attainment of engineering design goals
    - demonstrate the feasibility of conceptual approaches,
    - evaluate design risk,
    - identify design alternatives,
    - compare and analyze trade-offs, and
    - estimate satisfaction of operational requirements.
  - Later Phases (OT&E), focuses on questions of
    - operational effectiveness,
    - suitability and
    - supportability.
  - DT&E and OT&E are not necessarily serial phases in the evolution of a system.
Cost Communities Role in Program Life Cycle

- Prior to Milestones 0 & I:
  - Provides estimates to support design trades

- Prior to Milestone II:
  - Provides LCC estimates to support Analysis of Alternatives
  - Assists in defining CAIV
  - Develops Program Office LCC estimate
  - Develops independent LCC assessments: OSD CAIG and service cost organizations

- Prior to Milestone III:
  - Provides PO estimate for procurement
  - Develops independent LCC assessments: OSD CAIG and service cost organizations

- During EMD and production
  - Tracks actual EMD and procurement costs: Contractor Cost Performance Reports (CPRs) and Contract Cost Data Reports (CCDRs) and government costs

- During deployment and operations
  - Tracks actual O&S costs: VAMOSC Systems (Navy VAMOSC, Air Force Total Ownership Cost, and Army OSCMIS)
Role of the OSD Cost Analysis Improvement Group (CAIG)

Implement 10 U.S.C.2434 (Reference (h)) and DoD Instruction 5000.2 (Reference (f))

- For Milestone II and III Reviews. Prepare report on their independent estimate of program life-cycle costs of each Category ID program

- For a Category IC program, provide a similar report at either Milestone II or III
Scope of the CAIG Independent LCC Estimate

Cover all elements of the total life-cycle costs of the program including the following:

• Cost of all research and development efforts,
• Cost of the prime hardware and its major subcomponents to include:
  – support costs (including training, peculiar support equipment, and data),
  – initial spares,
  – military construction costs, and
  – the cost of all related procurements (including, where applicable, modifications to existing aircraft or ship platforms)
• Operating and support costs
Bases for the CAIG Estimate

• Based on cost analysis requirements description (CARD) provided by Service,

• Examine the mutual consistency of the CARD with
  – current threat,
  – operational requirements, and technical requirements documents;
  – and with contractual documents, including requests for proposals.

• Report any instances of significant inconsistencies and provide an assessment of their potential implications for cost

• Review each of the program and estimating assumptions, and provide its opinion of their validity in its report.
OSD CAIG Risk Assessment.

• Include quantitative assessments of the risk in the estimate of life-cycle costs.
  – Consider the validity of such programmatic assumptions of the CARDs as
    • EMD schedules,
    • rates of utilization of test assets,
    • production ramp rates, and
    • buy rates

• Consider uncertainties in inputs to
  – any cost estimating relationships (CERs) used in its estimates,
  – as well as the uncertainties inherent in the calibration of the CERs, and
  – uncertainties in the factors used in making any estimates by analogy.

• Consider cost and schedule risk implications of the program's technical risks
Where T&E and LCC Analysis Are Linked

• Both directly address risks in programs
  – T&E helps reduce risks and assess progress toward meeting program requirements
  – LCC analyses assess the cost and schedule risks to help determine if a program is affordable

• LCCs include estimates of T&E resources

• LCC analysis uses data from T&E experience as a basis for critical elements O&S estimates as programs moves from EMD to Procurement
Elements in Estimating the Cost of T&E
(Aircraft used as example)

- Contractor T&E
  - System Test and Evaluation
    - Ground tests including subsystem costs
      - subsystem qualification and R&M
      - wind tunnel
      - T&E support
      - static, fatigue, and drop
      - facilities
    - Other costs
      - Mockups
      - T&E support to government DT&E, OT&E, and operational evaluations
      - facilities
  - Contractor flight testing
- Government Tests
  - DT&E and combined DT/OT Flight tests
  - Live fire
Methods Used to Estimate T&E Costs

- Separate estimates for contractor and government test costs
- Contractor T&E costs
  - Cost Estimating Relationships are developed using historical CCDR and CPR data
  - Examples:
    - Contractor subsystem tests: labor hours = labor hours/lb X total of subsystems aircraft unit weight
    - Contractor flight tests: labor hours = labor hours/flying hours X projected total test flight hours
- Government T&E costs
  - System specific staffing costs at test ranges are estimated based on staffing requirements
Average Fighter Aircraft Contractor T&E Costs Compared to Contractor Total EMD Costs
FY 1999 Dollars Millions

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<th>Total Test Labor Hours</th>
<th>Total Test $M</th>
<th>Total EMD Labor Hours</th>
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Approximately 19% of the total T&E labor hours are estimated to be hardware related leaving 25% for direct support.

Life Cycle Cost Element Structure

- RDT&E
- EMD
- Procurement
  - Non-recurring system costs
  - Recurring system costs
  - Support costs (including training, peculiar support equipment, and data),
  - Initial spares,
  - Military construction costs, and
  - All related procurements (system modifications)
- O&S
- Disposal
Aircraft EMD Cost Elements & Work Breakdown Structure

- Level 1: Program
- Level 2: Program Elements
  - Air Vehicle
  - System Test & Evaluation
  - System Engineering/Program Management
  - Integrated Logistics Support
  - Other
- Level 3: Air Vehicle Elements
  - Airframe
  - Propulsion
  - Avionics
  - Armament
  - Other
- Level 4: Functions
  - Engineering
  - Tooling
  - Manufacturing
  - Quality Control
O&S Cost Element Structure

• Mission Personnel
  – Operations
  – **Maintenance**
  – Other

• Unit-Level Consumption
  – **POL**
  – **Consumables**
  – **Depot-Level Reparables**
  – Other

• Depot Maintenance
  – **Airframe Overhaul**
  – **Engine Overhaul**
  – Other

**Bold** = areas where T&E plays a role in O&S costs estimates

• **Contractor Support**
  • Sustaining Support
    – Support Equipment Replacement
    – **Modification Kit Procurement/Installation**
    – Sustaining Engineering
    – **Post Deployment Software Support**
    – Simulator Operations

• Indirect Support
  – Personnel Support
  – Installation Support
O&S Cost Estimating Linkage to T&E

- Critical O&S cost elements are driven by the system’s reliability and maintainability characteristics
  - R&M characteristics are used to determine
    - maintenance staffing - Logistics Cost of Ownership Model (discrete event simulation of maintenance networks)
    - consumable and depot level reparable spare parts
    - Airframe and engine overhaul/rework requirements
    - Interim contractor support requirements
  - During EMD T&E results including reliability growth maintenance repair time experience are used to estimate R&M characteristics of a mature system
O&S Cost Estimating Linkage to T&E (Continued)

- T&E costs are estimated for major modifications after deployment of the weapon system
- T&E costs are estimated for major software block updates
Data Sources

• Contractor T&E costs:
  – Cost data and models developed by DoD
  – Earned Value Management System
    • Managed by OSD(A&T)
    • Cost Performance Report
    • Cost/Schedule Status Report
  – Contract Cost Data Reports (Proprietary Data)
    • Managed by OSD(CAIG)
    • Provides actual costs during EMD and production by Contract Work Breakdown Structure

• Government T&E costs: Service Cost Agencies
Current Experience and Capability to Estimate Fixed-Wing Aircraft LCCs

- The colors indicate capability to estimate costs in that cost element.
- Dollars shown under the phase represent the FYDP years FY 1999 to 2005.
- Percentages next to the phase indicate the typical percentage of total life-cycle cost.
- Individual WBS percentages reflect their portion of the phase in total. Percentages for RDT&E are shown in whole because PDRR and EMD could not be broken out.

O&S costs for new systems represent about 41% of LCC; however, this may tend to underestimate actual % because we tend to underestimate O&S costs during system development and early procurement and systems lives are longer.
# FYDP Representation

## RDT&E
- ATIRCM/CMWS
- Joint Strike Fighter (JSF)
- E-2C Reproduction
- F/A-18 E/F
- CEC
- C-17A
- Airborne Laser (ABL)
- B-1B CMUP/DSUP/JDAM/COMP UP
- F-22
- JSTARS
- JPATS

## Procurement
- Black Hawk (UH-60L)
- ATIRCM/CMWS
- Longbow Apache
- T-45TS
- E-2C Reproduction
- AV-8B Remanufacture
- F/A-18 E/F
- CEC
- C-17A
- C-130J
- B-1B CMUP/DSUP/JDAM/COMP UP
- F-22
- JSTARS
- AWACS RSIP (E-3)
- JPATS
Fixed-Wing Test & Evaluation
Aircraft Estimating Source List

- MACDAR Fighter Aircraft Database, Tecolote, 1998
- Advanced Fighter Aircraft Cost Model, AFCAA, 1998
- Development Eng. and BTL Development Cost Models, Technomics, Aug 1990
- Assessing Acquisition Schedules for Tactical Aircraft, IDA 1989
- Aircraft Airframe CERs, RAND, 1987 (Total Level)
Research Efforts Recently Completed

- Defense Contractor Overhead Rate Analysis, NAVAIR, 1998 (follow-on)
- MACDAR Fighter Aircraft Database, Tecolote, 1998 (follow-on)
- Advanced Fighter Aircraft Cost Model (JSF), AFCAA, 1998
- Air Force Total Ownership Cost (AFTOC) MIS, MCR, 1998 (follow-on)
Areas Most in Need of Further Research

- Avionics
- Modifications (structural and avionics)
- Software
- Test and Evaluation
Summary

• Both T&E and LCC analysis address program risks
• LCC estimates include estimates of T&E costs
• T&E results are used to
  – estimate the O&S costs of a mature system
  – estimate the interim contractor logistics costs while in transition to the mature system