Presented at the 2007 ISPA/SCEA Joint Annual International Conference and Workshop - www.iceaaonline.com

Life Cycle Cost Normalization for Comparability

Presentation to:
2007 Joint ISPA-SCEA International Conference and Workshop
12-15 June 2007

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Preface

- This briefing focuses on Life Cycle Cost (LCC) 'normalization processes' developed and used by Summit Engineering Group
- The completeness, accuracy, and comparability of the LCC Data and Cost 'Metrics' were/are key requirements

Discussion Topics

- Background
- Case Study
- Cost as a Key Consideration
- Cost Groundrules and Assumptions
  - Quantity Profiles
  - WBS Elements
  - Calculation & Reporting of Cost Metrics
- LCC Model / Document Deliverables
  - Due Dates
  - Criteria & Maturation Schedule
- Questions

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Background

- Summit Engineering Group has developed and refined this approach over several engagements
  - DARPA Unmanned Combat Armed Rotorcraft (UCAR) program
  - DHS Counter-MANPADS (CM) program
- Common traits
  - Multiple vendors developing LCC for differing approaches to common capability
  - Strong emphasis on meeting cost targets
  - Multi-phased program
  - LCC impacts that extended far beyond the program

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Case Study

- DHS Science and Technology (S&T) Directorate tasked with demonstrating the technical feasibility, assessing life cycle costs, and evaluating the effectiveness of protecting commercial aircraft against the threat of Man-Portable Air Defense Systems (MANPADS)
- Primarily focused on mature Directed Infrared Countermeasure (DIRCM) systems
  - Self-contained pod
  - Distributed installation
- Complex problem due to
  - Multitude of aircraft types (Wide-body vs. Narrow-body)
  - Varying flight profiles as a function of aircraft type
  - Multiple operating environments (Cargo vs. Passenger)
  - Potentially large lost revenue costs for installations that fall outside normal maintenance cycles

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Acronyms

- A/C = Aircraft
- CM = Counter-MANPADS
- DHS = Department of Homeland Security
- DIRCM = Directed Infrared Countermeasures
- ITAR = International Traffic in Arms Regulation
- LCC = Life Cycle Cost
- MFHBF = Mean Flight Hour Between Failure
- MTBF = Mean Time Between Failure
- MTBUMA = Mean Time Between Unscheduled Maintenance Action
- NB = Narrow Body
- OEM = Original Equipment Manufacturer
- O&S = Operations and Support
- P^3I = Pre-Planned Product Improvement
- RDT&E = Research, Development, Test, and Evaluation
- STC = Supplemental Type Certificate
- T_1 = First Unit
- WB = Wide Body

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Cost as a Key Consideration

- Increased Emphasis on Life Cycle Cost (LCC)
- All Stakeholders Need Insights into Applicable Costs
  - Planning and Budgeting for Potential Implementation Impacts
- Eliminate Surprises
  - Build and Install Counter-MANPADS Units on Commercial Aircraft
  - Operations, Support, and Disposal Activities
  - FAA Certifications (Across All Applicable Aircraft Models)
  - Relevant Security & ITAR Export Controls
  - Emergency Ground Notification Policies & Procedures

Goal: Minimize Impacts to Commercial Aviation !

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DHS Counter-MANPADS Cost Goals

Constant GFY03 $

	Threshold	Goal
Unit Cost	<$1M for 1,000th Unit	<$500K for 1,000th Unit
O&S Cost	<$300 per Takeoff and Landing	<$150 per Takeoff and Landing

Unit Cost = Average Cost of Labor and Material for Counter-MANPADs Equipment, Aircraft Modifications, Installation of Counter-MANPADs Equipment, and associated Systems Engineering/Program Management, Data

O&S Cost = Average Cost of Labor and Material for Operating and Maintaining the Counter-MANPADs Equipment (H/W and S/W) and associated Commercial Aircraft Impacts, including Training of Personnel, Applicable Fuel and Drag Impacts, Support Equipment & Facilities. [Note: Excludes Potential Revenue Losses for Reactions to Emergency Notifications.]

GFY = Government Fiscal Year

O&S = Operations & Support

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DHS LCC Estimate Goals

- Comprehensive accounting of all foreseeable costs
- Explicitly address key LCC parameters
  - STCs and follow-on P3I / testing
  - Production rate tooling/test equipment (& for depot)
  - Investments to achieve reliability growth
  - CM system weight/drag impacts to fuel consumption
- Consistent approaches among vendors' LCC estimates so individual results could be leveraged
- Exercise LCC across various quantity profiles

Cost Groundrules & Assumptions

LCC 'Normalization'

Summit Engineering Group role was to …

- Develop comprehensive Cost Ground Rules and Assumptions
  - Define common assumptions for topics that were beyond the scope of the program
  - Develop application cases that would shed light on key production and installation constraints
  - Provide guidance on WBS structure and content
  - Promulgated and updated at each major program milestone
- Interface with vendors on developing detailed Manufacturing Rate Assessments
- Guide progressive maturation of LCC models and documentation

Overarching 'Normalization' Challenges

- Aircraft Demographics
- Common Work Breakdown Structure (WBS)
- DIRCM Configurations
- Aircraft Installation Approach
- Other

Aircraft Demographics

- ~350 Days per Year
- Wide body (WB)
  - Multi-aisle
  - Longer flights at altitude
  - More passengers per aircraft
  - ~2 flights/ day, ~6.8 hours/ flight
- Narrow body (NB)
  - Single-aisle
  - Shorter, more frequent flights
  - Fewer passengers per aircraft, but higher total passenger volume
  - ~5 flights/ day, ~2.3 hours/ flight
- Cargo is ~1,000 of total

Aircraft	Type	Fleet Size*
777	WB	122
767	WB	334
747	WB	108
DC/MD10	WB	99
MD11	WB	74
A300	WB	140
A310	WB	64
A330	WB	29
A318/19	NB	279
A320/21	NB	368
717/727	NB	271
737	NB	1241
757	NB	617
DC8,9/MD80/90	NB	703
	Total**	**4,449**

* Circa 2006 ** Excludes ~1,600 regional jets

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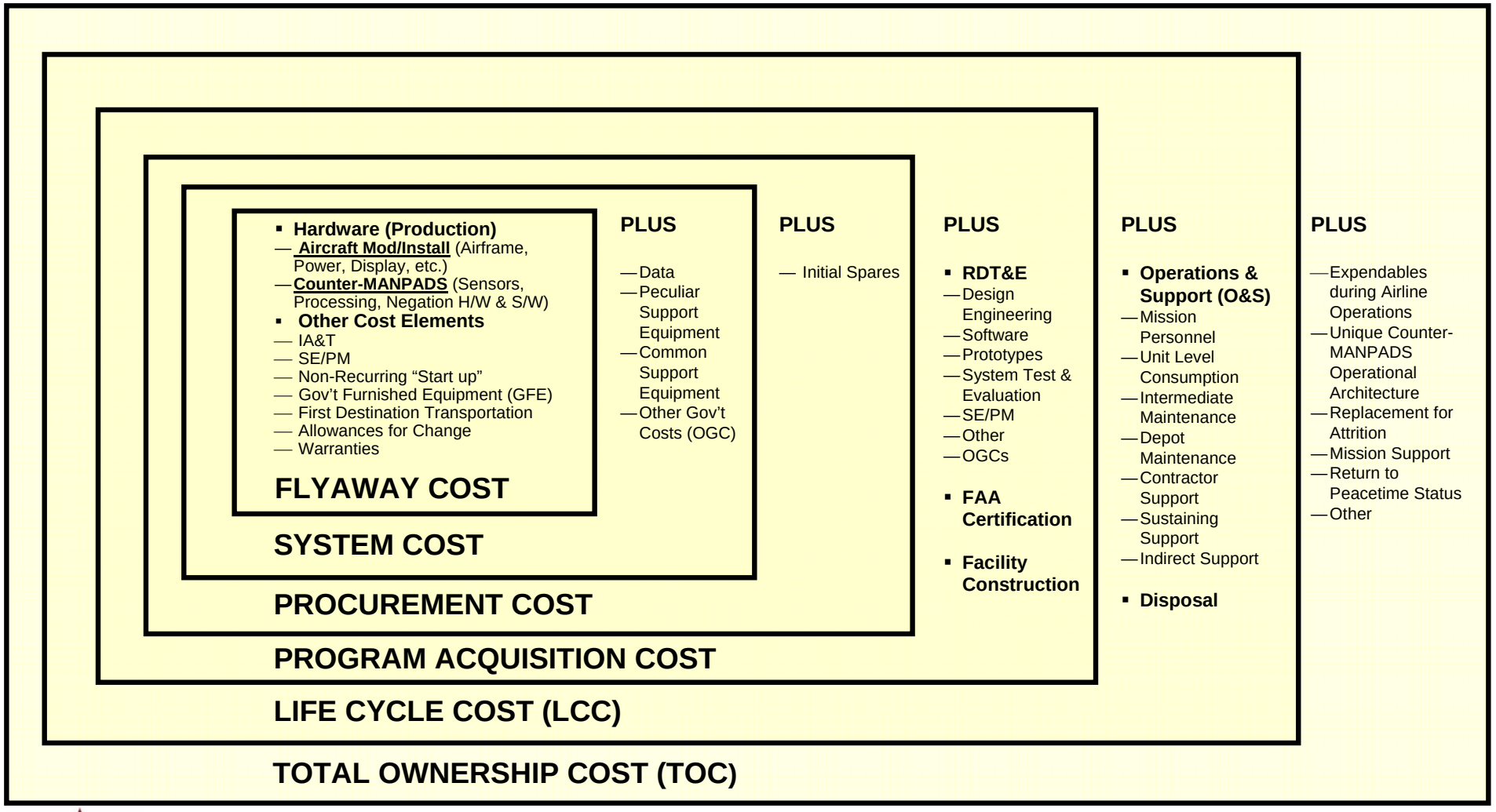
Civil Counter-MANPADS Cost Elements



Example Quantity Profiles*

- Civil Reserve Air Fleet (CRAF)-like [~ 100]
- All Wide-Body Passenger [~ 500]
- All Wide-Body [~1,000]
- All Narrow & Wide Body Passenger [~3,700]
- All Passenger and Cargo [~4,500]

*BACK Aviation Database, March 2006

Other 'Normalization' Assumptions

- Quantity of CM Systems and Aircraft Modified for both DIRCM Suppliers
- Production start & initial deployment in FY08
- 20-year service life
- 2-level maintenance (Airport and OEM/Depot)
- $2.00/gallon (BY03) applied to CM system induced fuel consumption
- >525 A-kit installs/ year could a 'special visit' penalty

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LCC Model/Document

TOC/LCC Deliverables

Deliverables	Due Dates			
LCC Model	Drop1	Drop 2	Drop 3	End of Phase (Drop 4)
LCC Document	--	Drop 1	--	End of Phase (Drop 2)

Example of LCC Model Criteria Maturation

LCC/TOC Model Criteria	Deliverables			
	Drop 1	**Drop 2**	**Drop 3**	**Drop 4**
1. Utilizes the updated DHS PO common groundrules and assumptions in determining the TOC and LCC projections.	- Some incorporated	- All incorporated	- All incorporated	- All incorporated
2. Establish and use a baseline LCC across all subsequent trade-off analyses.	- As Applicable	- As Applicable	- As Applicable	- As Applicable
3. A logical and traceable LCC Model structure exists.	- Complete; updated as necessary for Ph III	- Complete; updated as necessary for Ph III	- Complete; updated as necessary for Ph III	- Complete; updated as necessary for Ph III
4. As applicable, each WBS element has an estimated cost per year (at least BY03).	- Most calculation/ linkage errors fixed	- All calculation/ linkage errors fixed	- Complete	- Complete
5. Contractor provides any other applicable amplifying cost groundrules and assumptions for its LCC/TOC estimates.	- As Applicable	- As Applicable	- As Applicable	- As Applicable
6. Conducted at the lowest feasible equipment level.	- Updates to Phase II Level	- Partially incorporate agreed to lower level detail in selected areas	- Complete	- Complete
7. Separate visibilities into RDT&E, Procurement, O&S, Disposal, etc phase costs.	- All	- All	- All	- All
8. Sensitive to reliability, maintainability, quantity, CONOPS, OPTEMPO, unit production cost, and logistics program planning factors (sites, number of units, etc.) assumptions.	- Updated some assumptions based on experience/actual cost (T1, reliability, etc.)	- Updated most assumptions based on experience/actual cost (T1, reliability, etc.)	- Assumptions updated and sensitivity analyses run	- Fully quantified sensitivity to key cost drivers

Example of LCC Document Criteria Maturation

LCC Document Criteria	Deliverables	
	Drop 1	**Drop 2**
1. Utilizes the updated DHS PO common groundrules and assumptions in determining the TOC and LCC projections.	- Scope and intent of almost all DHS Cost Groundrules and Assumptions updates are Addressed	- Scope and intent of all DHS Cost Groundrules and Assumptions updates are Addressed
2. References that a baseline LCC was used across all trade-off studies performed.	- Formal LCC Baseline and associated parameters were used in the relevant trade studies	- Relevant LCC Parameters for all trade studies used and documented
3. Discuss the logic and structure of the companion LCC Model. Tells what is in it, Model Controls, and why relevant to CM.	- All of the companion LCC Model "features" discussed, including Ph III updates	- All of the companion LCC Model "features" discussed, including Ph III updates
4. As applicable, summarizes each WBS element and the overall approach for deriving the estimated cost per year (at least in BY03).	- The costs and approaches for all WBS elements are summarized, including applicable Ph III updates	- The costs and approaches for all WBS elements are summarized, including all necessary Ph III updates
5. Illustrates the software/hardware (CI) level of detail addressed. At least, the A-Kit, B-Kit, O&S elements	- All A-kit/B-Kit and O&S cost metric CI items addressed, including updates for Ph III	- All A-kit/B-Kit and O&S cost metric CI items addressed, including all new Ph III information
6. Separate visibilities into RDT&E, Procurement, O&S, Disposal, etc. phase costs are provided. Rationale for transitions provided.	- The costs for all WBS elements within each phase are separately captured	- The costs for all WBS elements within each phase are separately captured
7. BOEs provide sufficient details so that the cost estimates could be easily reconstructed using the LCC Document. This includes source data, estimating method, equations, factors, etc. used to derive the cost of the WBS element.	- An updated for Ph III Estimate (BOE) exists for each WBS element in the LCC Model	- Final validated Basis of Estimate (BOE) exists for each WBS element in the LCC Model

Cost Minimization Opportunities

- B-Kits (Counter-MANPADS Equipment)
  - Leverage Military Components & Commercial Practices
- MTBF ✈✈ MTBUMA and Impacts on $/Flight
  - Enhance Reliability and Security
- Deployment Schedule
  - Match Installs to Airlines' Heavy Maintenance Capacity
  - Goal is ~ $0 Lost Revenue
- A-Kits (Provisions for B-Kits)
  - Investigating OEM Forward Fit Options/Plans

MTBF = Mean Time Between Failure

MTBUMA = Mean Time Between Unscheduled Maintenance Action

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Cost Metrics

- All of the Cost Metrics should be calculated for each of the Quantity/Installation profiles
- The Composition (what WBS elements are used) for the Cost Metrics should be clearly Traceable to the LCC Model and LCC Document
- The Cost Metrics to be reported in the LCC Document
  - Unit Flyaway Cost
  - Installation Cost
  - O&S Cost per Take Off / Landing
  - Separate Cost by each Phase (RDT&E, Production, O&S, Disposal)
  - Total Ownership Cost

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Examples of LCC Sensitivities

DHS was interested in understanding the sensitivities of the LCC estimates to various 'Attributes', for example …

Attribute	+ / - %	Low	LCC	High
$/STC (New/Amend)	20	---	1.000	---
CM System T_1	15	---	1.000	---
CM System Learning Curve	5	---	1.000	---
Fuel ($/gal)	25	---	1.000	---
Fleet Drag (%)	20	---	1.000	---
Installed Weight (lbs)	10	---	1.000	---
Initial Reliability (MFHBF, WB/NB)	25	---	1.000	---
Order Quantity	5	---	1.000	---

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'Normalization' Insights

- Comparability of various LCC models is achievable
  - Requires concerted effort and focus throughout the program
- Need firm understanding of the desired 'end state'
- Must think through key 'cost drivers'
  - Those under the control of the vendors
  - Those outside the control of the vendors (assumptions)
- Assumptions must remain stable over a given phase of the program
- Definite LCC differences due to system configuration and not basic assumptions

Questions?

Presenter Biographies

- Mr. Kirk L. Hoy
  - Sr. Principal at Summit Engineering Group
  - Certified Cost Estimator/Cost Analyst (SCEA)
  - BS/BA Industrial Engineering/Economics (Lehigh University)
  - MS Systems Engineering (Virginia Tech)
  - 23+ years of systems engineering and cost estimation/analysis experience
- Mr. Kurt Willstatter
  - Sr. Principal at Summit Engineering Group
  - Certified Cost Estimator/Cost Analyst (SCEA)
  - BA Biology (Texas A&M)
  - MS Operations Research (Naval Post Graduate School)
  - 15+ years of systems engineering, modeling & simulation, cost estimation experience
  - 20 years of Navy operations and systems engineering

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