MORS Introduction to Cost Estimation (Part I)

Module Three – Phase 2: Assessment (Obtain the Data)

Mr. Huu M. Hoang

Disclosure Form

Module Three

Module #(s)	Items covered	Presenter	Start	Stop
One & Two	(1) Overview and Background (1) Define Estimate's Purpose (1) Develop Estimate Plan -- (2) Define Program (2) Determine Estimate Structure (2) Identify Ground Rules and Assumptions	Huu	13:00	14:30
Break	N/A		14:30	14:45
Three	**Obtain data**	**Huu**	**14:45**	**15:45**
Break	N/A		15:45	16:00
Four	Develop point estimate	Huu	16:00	17:00

Learning Objectives of Module Three

1. Understand how to create a data collection plan

2. Understand how to collect data and normalize it

3. Understand how to analyze the data for cost drivers, trends, and outliers

4. Understand how to document and store data

Phase 2: Assessment
Step Six

Module Three – Phase 2: Assessment (Obtain the Data)

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Data Cycle

Collect → Normalize → Document → Archive → Collect

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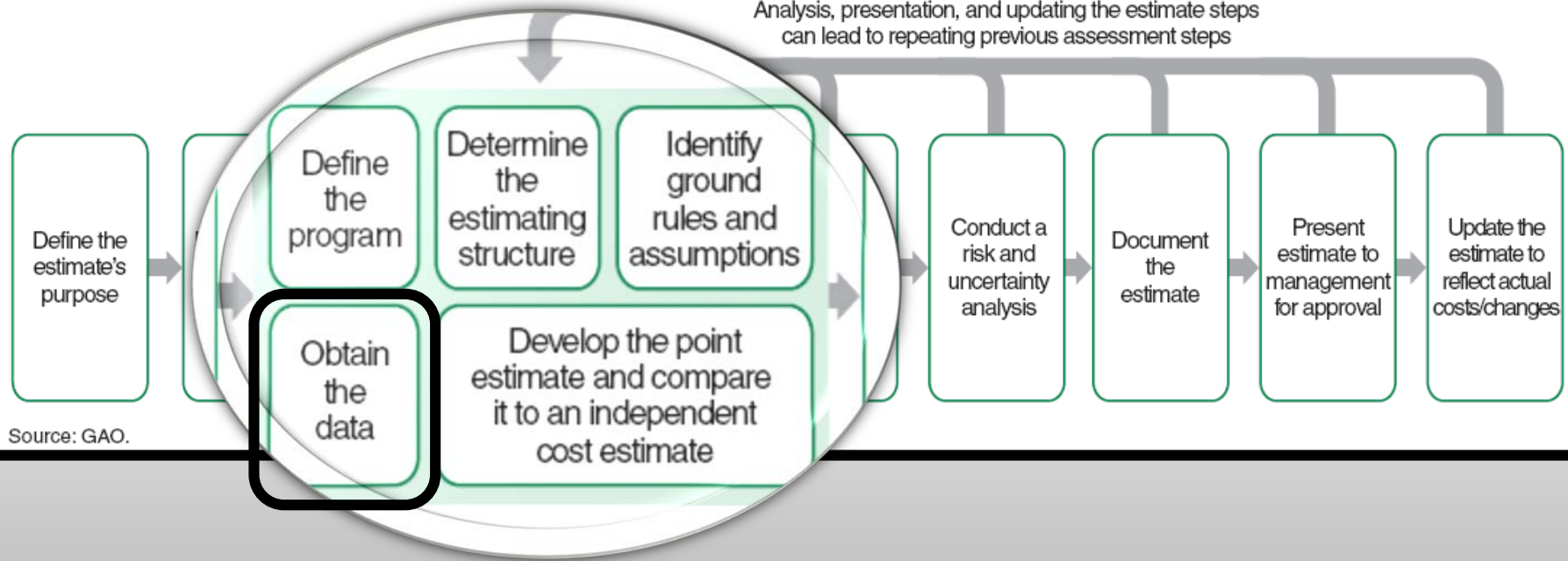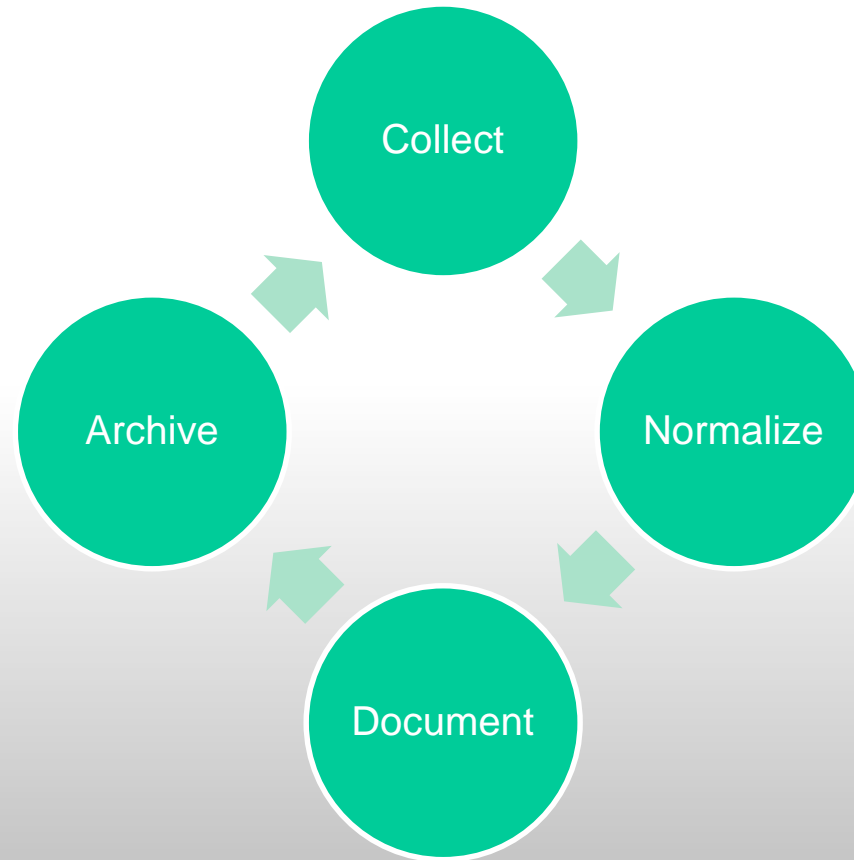
Overview of Data

- Data are the foundation of every cost estimate
  - The quality of the data affects the overall credibility of the cost estimate
  - Crosschecking different data sets for concurrence provides a high degree of confidence in the data

- Estimators rely on data from existing programs in order to estimate the cost of new programs

- All WBS elements will need data for support
  - Both cost and non-cost data are needed to support various estimating techniques

Data – Quality of Data Types
Order of Priority

1. <u>Actuals</u> for completed programs from cost reports - Cost and Software Data Reporting (CSDRs)

2. Estimates at Complete (EACs) for contracts greater than 90% complete – Cost Performance Reports (CPRs)

3. Contractor line item prices from Section B (Prices by CLIN) in contract

4. Historical budget data

5. Subject Matter Expert (SME) input

Degree of Actuals

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Types of Data Collection

- ## Interviews
  - Interviews can be conducted in person or over the telephone
  - Interviews can be done formally (structured), semi-structured, or informally
  - Questions should be focused, clear, and encourage open-ended responses
  - Interviews are mainly qualitative in nature

- ## Questionnaires and Surveys
  - Responses can be analyzed with quantitative methods
  - Results are generally easier (than qualitative techniques) to analyze
  - Pre-test/Post-test can be compared and analyzed
  - Results of a satisfaction survey or opinion survey

- ## Observations
  - Allows for the study of the dynamics of a situation, frequency counts of target behaviors, or other behaviors as indicated by needs of the evaluation
  - Good source for providing additional information about a particular group, can use video to provide documentation
  - Can produce qualitative (e.g., narrative data) and quantitative data (e.g., frequency counts, mean length of interactions, and instructional time)

- ## Focus Groups
  - A facilitated group interview with individuals that have something in common
  - Gathers information about combined perspectives and opinions
  - Responses are often coded into categories and analyzed thematically

- ## Documents and Records
  - Consists of examining existing data in the form of databases, meeting minutes, reports, attendance logs, financial records, newsletters, etc.
  - This can be an inexpensive way to gather information, but may be an incomplete data source

How to create a data collection plan

- Preparation & Expectation
  - Inform Cost Team Leads and Stakeholders
  - Understand the scope of the estimate (Program of Record - POR)
- Conduct
  - Set your "proper expectations" up front on what you plan to accomplish
  - Use the proper techniques to extract data
  - Focus on the agenda, don't let others distract your meeting
  - Time management is very important so think wisely
- Review & Clarification
  - Review for completeness
  - Review for clarity
  - Review for accuracy
  - Request Defense Contract Management Agency (DCMA) and Defense Contract Audit Agency (DCAA) for verification
- Acceptance
  - Send a courtesy email to Contractor
  - Give contractor a quick reminder that we are still waiting for the remaining data that we discussed at the meeting (if any)

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Possible Sources of Data

- **Cost Analysis Data Enterprise (CADE)**
  - **CSDRs**

The CSDR Requirement applies to all ACAT IAM, IAC, IC, and ID programs, as outlined below, regardless of contract type.

Report	When Required
Contractor Cost Data Report (CCDR)	▪ All contracts greater than $50M ▪ High-risk or high-technical interest contracts between $20M and $50M*
Software Resource Data Report (SRDR)	▪ All contracts with software effort greater than $20M ▪ High-risk or high-technical interest contracts below $20M*

*Left to the discretion of the DoD Program Manager with approval by the Deputy Director of Cost Assessment.

  - **CPRs**
- **Operating & Support**
  - **Services (VAMOSC, OSMIS, & AFTOC)**
- **Acquisition Program Baselines (APBs)**
- **Selected Acquisition Reports (SARs)**
- **Labor Rates and Forward Pricing Rate Agreements (FPRAs) from DCMA and DCAA**

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Step 6: Obtain Data
Data Validity

- It is important to ensure that the collected data apply to the cost estimate

    – For example, do not use data from a mainframe technology if the new program will use servers.

- Cost data will eventually become dated

    – New data must continually be collected in order to make comparisons and develop trends.

- To address data limitations, an analyst must

    – Ensure that the most recent data are collected

    – Have a thorough knowledge of the data's background

    – Discuss limitations and uses with the data provider

    – Identify the correlation between cost and performance data.

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Normalization of Data
Cost Accounting (Direct versus Indirect)

- ## The two types of cost data are
  - **<u>Direct costs</u>**: costs that have a direct bearing on the production of goods
  - **<u>Indirect costs</u>**: costs that are typically charged to the company as a whole
- ## An estimator must understand which historical costs are burdened to avoid double-counting or underestimating

Type of cost data	Examples
Direct ("touch labor")	Direct manufacturing, engineering, quality assurance, material, training, supplies, related travel
Indirect costs ("overhead")	General and administrative support, rent, utilities, insurance, network charges, fringe benefits, leave, retirement, health insurance

Normalization of Data
Cost Accounting (Direct versus Indirect Definitions)

- **Direct Labor**
  - Direct Salary (Gross Pay)
  - Depends on selected labor categories

- **Indirect Functions**
  - Fringe Benefits
    - Paid time off (PTO) – vacation, sick, holiday
    - Health and Vision Plans
    - 401K and other pension/retirement plans
  - Overhead Expenses
    - Supervisor and Management Salaries
    - Operating Expenses (Leases, Utilities, etc.)
  - Subcontract and Material Burdens
  - General and Administrative (G&A) expenses
  - Facilities Capital Cost of Money (FCCOM)

Multiple of Indirect to Direct (not Including Fee/ Profit) is known as wrap rate. Comes from companies Forward Pricing Rate Agreement (FPRA)

Normalization of Data
Cost Accounting (Calculation of Wrap Rate)

- Contractor rates from FPRA (usually not more than five years out)
  - Approved by DCMA
  - Values and how calculated vary from one contractor to another
  - Further analysis required to predict outyears

- Below is notional wrap rate (thru G&A) calculation
  - FCCOM and profit/fee not included

Info Provided		Value	$$	Notes
Direct Labor	DL	$35.00	$35.00	Labor Category for OR Level III
Fringe	F	35%	$12.25	Multiply (DL) x (F)
Overhead	OH	75%	$35.44	Multiply OH X (DL + F)
G&A	GA	16%	$13.23	Multiply GA X (OH + F + DL)
Total thru G&A	Total		$95.92	DL + F + OH + GA
Wrap Rate (thru G&A)	Wrap		2.74	Total / DL

Normalization of Data
Cost Accounting (Exercise Calculation of Wrap Rate)

- Calculate the wrap rate with the information provided below:

Info Provided		Value	$$	Notes
Direct Labor	DL	$43.00	$43.00	Labor Category for OR Level IV
Fringe	F	30%	$xx.xx	Multiply (DL) x (F)
Overhead	OH	67%	$xx.xx	Multiply OH X (DL + F)
G&A	GA	18%	$xx.xx	Multiply GA X (OH + F + DL)
Total thru G&A	Total		$xx.xx	DL + F + OH + GA
Wrap Rate (thru G&A)	Wrap		x.xx	Total / DL

Normalization of Data
Background on Inflation

FY	NCCA Reference (Base Year = FY06)	2006	2007	2008	2009	2010	2011	2012
NOTIONAL RAW INFLATION (2.2% Inflation)	Raw Index	1	1.022	1.044	1.066	1.088	1.11	1.132
NOTIONAL OUTLAY RATE		YR1 25%	YR2 45%	YR3 15%	YR4 10%	YR5 5%	Total 100%	
FY$ COST NOTIONAL PROC		$ 1,000			$ 1,000			$ 1,000
BY06$ INFLATOR		1.0275						
BY06$ COST NOTIONAL PROC		$ 1,027.5			$ 1,027.5			$ 1,027.5
TY$ INFLATORS WEIGHTED INDEX	Weighted Index	1.0275	1.0495	1.0715	1.0935	1.1155	1.1375	1.1595
TY$ COST NOTIONAL PROC		$ 1,027.5			$ 1,093.5			$ 1,159.5
BY06$ TO TY$ INFLATORS	Budget Year Index	1	1.021411	1.042822	1.0642336	1.085645	1.107056	1.1284672

Arrows: **Constant FY06$** → FY$ COST NOTIONAL PROC; **Constant BY06$** → BY06$ COST NOTIONAL PROC; **Then Year TY$** → TY$ COST NOTIONAL PROC

- Constant dollars expressed as Fiscal Year (FY) and Budget Year (BY) dollars
- FY dollars also called CY (Constant Year) and BY (Base Year) dollars
- Each appropriation has different inflation indices and outlay factors

Normalization of Data
Inflation Calculator

8-Jun-2016

Joint Inflation Calculator February 2016
Inflation Calculator For PB17 Budget
Main Sheet

Updated February 2016

This Joint Calculator was prepared by The Naval Center for Cost Analysis to provide Army and DON inflation rates and indexes for the cost estimating community. Inflation rates reflect OSD Inflation Guidance dated February 2016. **The post FYDP rate of increase for Fuel is an exception and has been set to 2.5% for all post FYDP years per SAR Guidance**

Workbook Contents

** **Inflation and Escalation** note on the difference and use in indices **Please read**	Inflation_Escalation
* **Instructions** and Points of Contact	Instructions
* **Query** allows users to select a base year and appropriation, and generate the standard inflation tables. It also has a "Quick Look" inflation calculator option.	Query
* **Inflation Table** holds the most recently generated inflation index table	Inflation Table
* **Examples_Notes** examples of using the indexes and notes on Composite and Manpower Indexes	Examples _Notes
* **DON Multi Appn** displays indexes for all appropriations on one sheet	Multi Appn
* **Army Multi Appn** displays indexes for all appropriations on one sheet	Army Multi Appn
* Selected Acquisition Report (**SAR**) contains parameters and instructions for SAR reports	SAR
* **SAR Calculator** converts then-year to base-year dollars	SAR Calculator
* **Army Notes** gives guidance to the Army community on the use of this calculator	Army Notes
* Appropriation and Cost Element **Titles**	Titles
* **Definitions** of calculator inflation terms	Glossary

Hidden sheets with source data

* The **Inflation** sheet has the annual FY to FY inflation rates for all years & appropriations.
* The **Composite** sheet has the cost element weightings for the thirteen composite appropriation indices received from N801.
* The **CombOutFac** sheet has the combined outlay factors used to calculate weighted indices for all appropriations.
* The **1970=1 Inflation Index** sheet converts **Inflation** sheet rates into 1970 Baseline (1.00) values

APN = Aircraft Procurement, Navy (1506)

NAVY   **Base Year = 2015**   26-Feb-16

Fiscal Year	Inflation Rate %	Raw Index	Weighted Index	Budget Year Index	Budget Year Inflation Rate %
1970	3.93%	0.1771	0.1872	0.1823	
1971	4.55%	0.1851	0.1951	0.1900	4.24%
1972	3.83%	0.1922	0.2045	0.1991	4.78%
1973	4.16%	0.2002	0.2255	0.2196	10.30%
1974	5.77%	0.2118	0.2363	0.2302	4.80%
1975	8.81%	0.2304	0.2493	0.2428	5.50%
1976	6.59%	0.2456	0.2660	0.2591	6.69%
197T	3.56%	0.2544	0.2814	0.2741	5.79%
1977	3.78%	0.2640	0.2949	0.2872	4.80%
1978	6.80%	0.2819	0.3235	0.3150	9.68%
1979	8.72%	0.3065	0.3618	0.3524	11.86%
1980	11.80%	0.3427	0.4037	0.3931	11.56%
1981	11.60%	0.3824	0.4494	0.4376	11.33%
1982	14.30%	0.4371	0.4882	0.4754	8.63%
1983	9.00%	0.4765	0.5193	0.5057	6.38%
1984	8.00%	0.5146	0.5402	0.5260	4.02%
1985	3.40%	0.5321	0.5558	0.5413	2.90%
1986	2.80%	0.5470	0.5728	0.5578	3.05%
1987	2.70%	0.5618	0.5929	0.5774	3.51%
1988	3.00%	0.5786	0.6187	0.6025	4.35%
1989	4.20%	0.6029	0.6434	0.6266	4.00%
1990	4.00%	0.6270	0.6656	0.6482	3.45%
1991	4.30%	0.6540	0.6847	0.6668	2.87%
1992	2.80%	0.6723	0.7001	0.6818	2.25%
1993	2.70%	0.6905	0.7132	0.6945	1.86%
1994	2.00%	0.7043	0.7264	0.7074	1.85%
1995	1.90%	0.7177	0.7381	0.7187	1.61%
1996	2.00%	0.7320	0.7484	0.7288	1.40%
1997	1.80%	0.7452	0.7549	0.7351	0.86%
1998	0.70%	0.7504	0.7636	0.7436	1.16%
1999	0.80%	0.7564	0.7734	0.7532	1.28%
2000	1.40%	0.7670	0.7837	0.7632	1.33%
2001	1.80%	0.7808	0.7930	0.7723	1.19%
2002	0.80%	0.7870	0.8031	0.7820	1.26%
2003	1.00%	0.7949	0.8191	0.7977	2.00%
2004	2.00%	0.8108	0.8407	0.8187	2.64%
2005	2.80%	0.8335	0.8644	0.8418	2.82%
2006	3.10%	0.8594	0.8884	0.8651	2.77%
2007	2.70%	0.8826	0.9091	0.8853	2.33%
2008	2.40%	0.9037	0.9227	0.8986	1.50%
2009	1.50%	0.9173	0.9356	0.9111	1.39%
2010	0.80%	0.9246	0.9551	0.9301	2.09%
2011	2.00%	0.9431	0.9741	0.9486	1.98%
2012	1.80%	0.9601	0.9880	0.9622	1.43%
2013	1.50%	0.9745	0.9987	0.9725	1.08%
2014	1.50%	0.9891	1.0117	0.9852	1.30%
2015	1.10%	1.0000	1.0269	1.0000	1.51%
2016	1.20%	1.0120	1.0446	1.0173	1.73%
2017	1.80%	1.0302	1.0645	1.0366	1.90%
2018	1.80%	1.0488	1.0854	1.0570	1.96%

https://www.ncca.navy.mil/tools/inflation.cfm

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Learning Curves

- Definition: A learning curve is a CER based on the theory that labor hours per unit decrease over time
  - Repetitive production often results in learning

- The following is the basic Learning Curve Formula (Unit Theory by James R. Crawford in 1947):
  - As the quantity of units produced doubles, the amount of effort declines by a constant percentage

$$Y = ax^b$$

Cost of the Lot Midpoint

Cost of the First Unit

Learning Curve Slope

Algebraic Lot Midpoint

Module Three – Phase 2: Assessment (Obtain the Data)

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Analyze Data
Trends, & Outliers

- Regression common method for data analysis
  - Common output is relationship with dollars or hours as dependent variable
  - Inputs such as weight, shaft horsepower or other technical parameters used as the independent variables
  - Statistical parameters such as Adjusted R2 (unit space), P-values, CV (Standard Deviation/Mean) used to analyze various equations

- Outliers
  - Values in data set outside range of defined criteria
  - Must determine inclusion or exclusion in data set
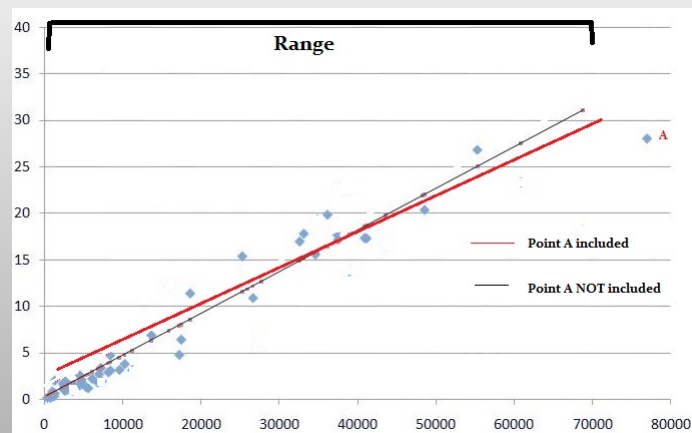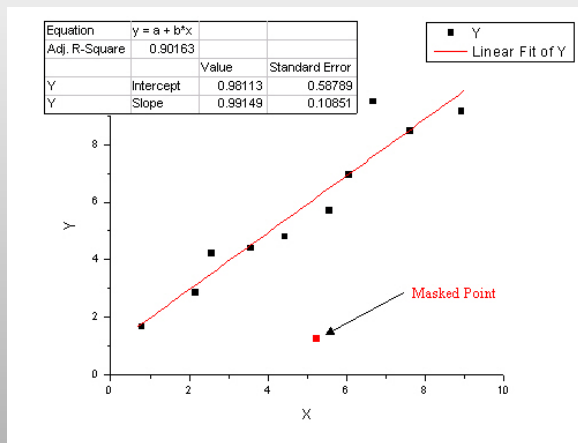
Analyze Data
Cost Drivers

- Identify the Major Cost Drivers in Each Phase of the Estimate
  - Greatest Percentage of Each Phase
  - Variables that contribute to greatest percentage of cost
  - Talk to SMEs
  - Understand technical and operational parameters
- Will also be analyzed
  in Step 7 ----------------→

Point Estimate
Total ($596,271.111)
At 90%, 110% of Point Estimate

BY2014 $K

$550,000 $570,000 $590,000 $610,000 $630,000 $650,000

AV
Total Flight Hours
Flight Hours
End Date of UPgrades
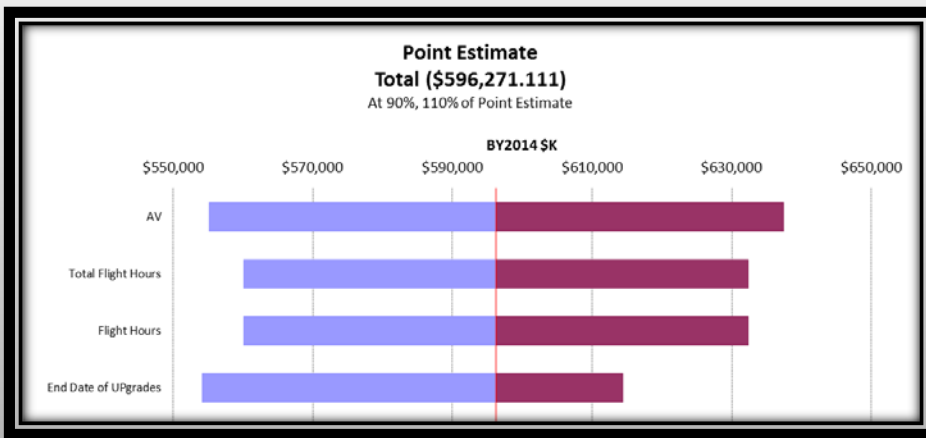
Document the Data

1. Indicate source of data to include date
2. Include the raw data and not just the normalized data
3. Ensure all units are all clearly
4. Comment on any limitations of the use of the data

Module Three – Phase 2: Assessment (Obtain the Data)

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Storage of the Data

1. Organize the data on storage so it is easy to search and find

2. Separate out any proprietary data and store in places where only authorized users can access (NDAs)

3. Add any technical and programmatic data to support cost data

Best Practices Checklist #6A
Obtain Data

❑ As the foundation of an estimate, its data:

– Have been gathered from historical actual cost, schedule and program, and technical sources

– Apply to the program being estimated

– Have been analyzed for cost drivers

– Have been collected from primary sources, if possible, and secondary sources as the next best option, especially for cross-checking results

– Have been adequately documented as to source, content, time, units, assessment of accuracy and reliability, and circumstances affecting the data

– Have been continually collected, protected, and stored in a database for future use

– Were assembled as early as possible, so analysts can participate in site visits to understand the program and question data providers

Module Three – Phase 2: Assessment (Obtain the Data)

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Best Practices Checklist #6b
Obtain Data

❑ Before being used in a cost estimate, the data were:

- – Fully reviewed to understand their limitations

- – Segregated into nonrecurring and recurring costs

- – Validated, using historical data as a benchmark for reasonableness

- – Current and found applicable to the program being estimated

- – Analyzed with a scatter plot to determine trends and outliers

- – Analyzed with descriptive statistics

- – Normalized to account for cost and sizing units, mission or application, technology maturity, and content so they are consistent for comparisons

- – Normalized to constant base-year dollars to remove the effects of inflation, and the inflation index was documented and explained

Module Three – Phase 2: Assessment
(Obtain the Data)

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Review of Learning Objectives of Module Three

1. Understand how to create a data collection plan

2. Understand how to collect data and normalize it

3. Understand how to analyze the data for cost drivers, trends, and outliers

4. Understand how to document and store data

Module Three

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Three	Obtain data	Huu	14:45	15:45
Break	**N/A**		**15:45**	**16:00**
Four	Develop point estimate	Huu	16:00	17:00

Module Three – Phase 2: Assessment (Obtain the Data)

Backup

…In the Cost Guide

Step	Description	Cost Guide Chapter	Phase in Process
1	Define estimate's purpose	5	Initiation & Research
2	Define estimate's plan	5, 6	Initiation & Research
3	Define program characteristics	7	Assessment
4	Determine estimating structure	8	Assessment
5	Identify GR&As	9	Assessment
6	Obtain data	10	Assessment
7	Develop point estimate and compare	11, 12, 15	Assessment
8	Conduct sensitivity analysis	13	Analysis
9	Conduct risk & uncertainty analysis	14	Analysis
10	Document the estimate	16	Analysis
11	Present estimate to management	17	Presentation
12	Update the estimate	16, 18, 19, 20	Presentation

Normalization of Data
Learning Curve/Rate (Quantity Adjustments)

Learning Curve Definition

• As the number of production units manufactured
  doubles, unit cost decreases by a constant percentage
  – Applies only to recurring costs
  – Also called Improvement Curve

Factors Affecting Learning Curves

• Ratio of manual labor to automated processes
• Greater automation reduces impact of individual experience gain
• Product complexity
• Greater opportunity for improvement inherent in more intricate product
• Work force stability
• Constant stream of inexperienced operators slows learning curve development
• Program stretch-outs (buy the same number but less each year than planned)
• As the learning curve matures (cost less), the number of units bought each fiscal year
has more impact than the total number of units in the program
• Production breaks
• Position on learning curve when production resumes dependent on length of interruption

Number of Units
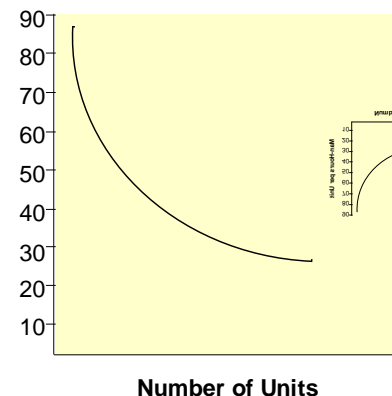
Reduction or increase in quantities is not a linear +/- in cost.

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(Obtain the Data)

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Normalization of Data
Cost Accounting (Exercise Calculation of Wrap Rate)

Answers from the wrap rate calculation exercise:

Info Provided		Value	$$	Notes
Direct Labor	DL	$43.00	$43.00	Labor Category for OR Level IV
Fringe	F	30%	$12.90	Multiply (DL) x (F)
Overhead	OH	67%	$37.45	Multiply OH X (DL + F)
G&A	GA	18%	$16.80	Multiply GA X (OH + F + DL)
Total thru G&A	Total		$110.15	DL + F + OH + GA
Wrap Rate (thru G&A)	Wrap		2.56	Total / DL

Basic Data Sources

Table 10: Basic Primary and Secondary Data Sources

Data type	Primary	Secondary
Basic accounting records	x	
Data collection input forms	x	
Cost reports	x	x
Historical databases	x	x
Interviews	x	x
Program briefs	x	x
Subject matter experts	x	x
Technical databases	x	x
Other organizations	x	x
Contracts or contractor estimates		x
Cost proposals		x
Cost studies		x
Focus groups		x
Research papers		x
Surveys		x

Source: DOD and NASA.

Calculations Using the Inflation Indices
Dollar Converter

Given Constant Dollars

Constant year dollars represent the buying power of the dollar in a specific year. Cost estimating relationships (CERs) and estimates are documented in constant or base year dollars.

Given Then Year Dollars

Then year dollars represent the amount needed when outlays on goods or services are made. Budgeted and appropriated funds are in then year dollars.

Divide by the raw index

Check for the correct service, appropriation, and year of the dollar you **begin** with.

Divide by the weighted index

Check for the correct service, appropriation, and year of the dollar you **begin** with.

Constant $$ in the Base Year of the Index

Using the same service and appropriation indices as before, check for the year of the dollar you want to **end** with.

Using the same service and appropriation indices as before, check for the year of the dollar you want to **end** with.

Multiply by the raw index

Multiply by the weighted index

Answer in Constant Dollars

Cost estimates are developed and documented in constant or base year dollars. Data sets are normalized to a constant or base year dollar prior to analysis.

Answer in Then Year Dollars

Budget requests such as the President's Budget (PB) and the Program Objective Memorandum (POM) are presented in then year dollars.

Source: DAU

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