MORS Introduction to Cost Estimation (Part I)

Module One – Overview and Phase 1 Initiation and Research

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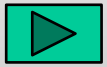
Admin
Introduction

- Introduction of Presenters
- Class Introductions
  - Name, Industry/Government, normal role, years of cost estimating
- Disclaimers and Acknowledgements
- Rules of Engagement
  - Personal experiences encouraged, but time limited
  - Welcome to stand at back of room, if getting tired
- Restrooms
  - Scheduled breaks, but be comfortable
- Cell Phone Usage
- Critique sheet at end of course

Admin

Course Material and Markings

1) Paper copies of:
   1) Four modules (w/o backup)
   2) Cost Estimating Best Practices Checklist
   3) Sample problem in Module Four
2) CD ROM
   1) Four modules (with backup and notes - PDF)
   2) GAO Guide (PDF)
   3) Joint Inflation Calculator (Excel)
   4) Cost Estimating Best Practices Checklist (Word)
   5) Sample problem in Module Four (Word)
3) Annotation on slides
   1) Key slide 
   2) Refer to backup slide for more info 
   3) Personal opinion

My personal opinion!!!

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Agenda of Today's Course

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

Module One

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**
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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

Learning Objectives of Module One

1. Understand the 12 steps of the Cost Estimating Process and How This Relates to the OR Process

2. Understand the Different Types of Estimates and how Life Cycle Cost Estimates (LCCEs) and Business Case Analysis (BCAs) fits into this 12 step process

3. Understand how to properly define an estimate's purpose and plan

Background

What is Cost Estimating?

- The International Cost Estimating and Analysis Association (ICEAA) has defined Cost Estimating as:
  - The art of approximating the probable cost of something based on information available at the time.
- Cost estimating cannot:
  - Be applied with cookbook precision, but must be tailored to a particular system,
  - Be a substitute for sound judgment, management, or control,
  - Produce results that are better than input data, or make final decisions.
  - Despite these limitations, cost estimating is a powerful tool because it:
    - Leads to a better understanding of the problem,
    - Improves management insight into resource allocation problems, and
    - Provides an objective baseline to measure progress.

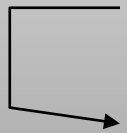
Cost Analysis/Estimation is as much an Art as it is a Science!

Background

Estimating vs. Analysis

- Cost analysis can be defined as:
  - the effort to develop, analyze, and document cost estimates with analytical approaches and techniques;
  - the process of analyzing and estimating the incremental and total resources required to support past, present, and future systems;
  - a tool for evaluating resource requirements at key milestones and decision points in the acquisition process.

- Cost estimating involves:
  - collecting and analyzing historical data;
  - applying quantitative models, techniques, tools, and databases;
  - predicting a program's future cost.



1. **Do not get wrapped up in these definitions**
2. **Analyze the past and present to estimate the future**

Background

Different Types of Cost Estimates

Life Cycle Cost Estimate

- Independent Cost Estimate (ICE)
- Total Ownership Cost (TOC)

Source: GAO

Business Case Analysis

- Analysis of Alternatives (AOA)
- Economic Analysis (EA)

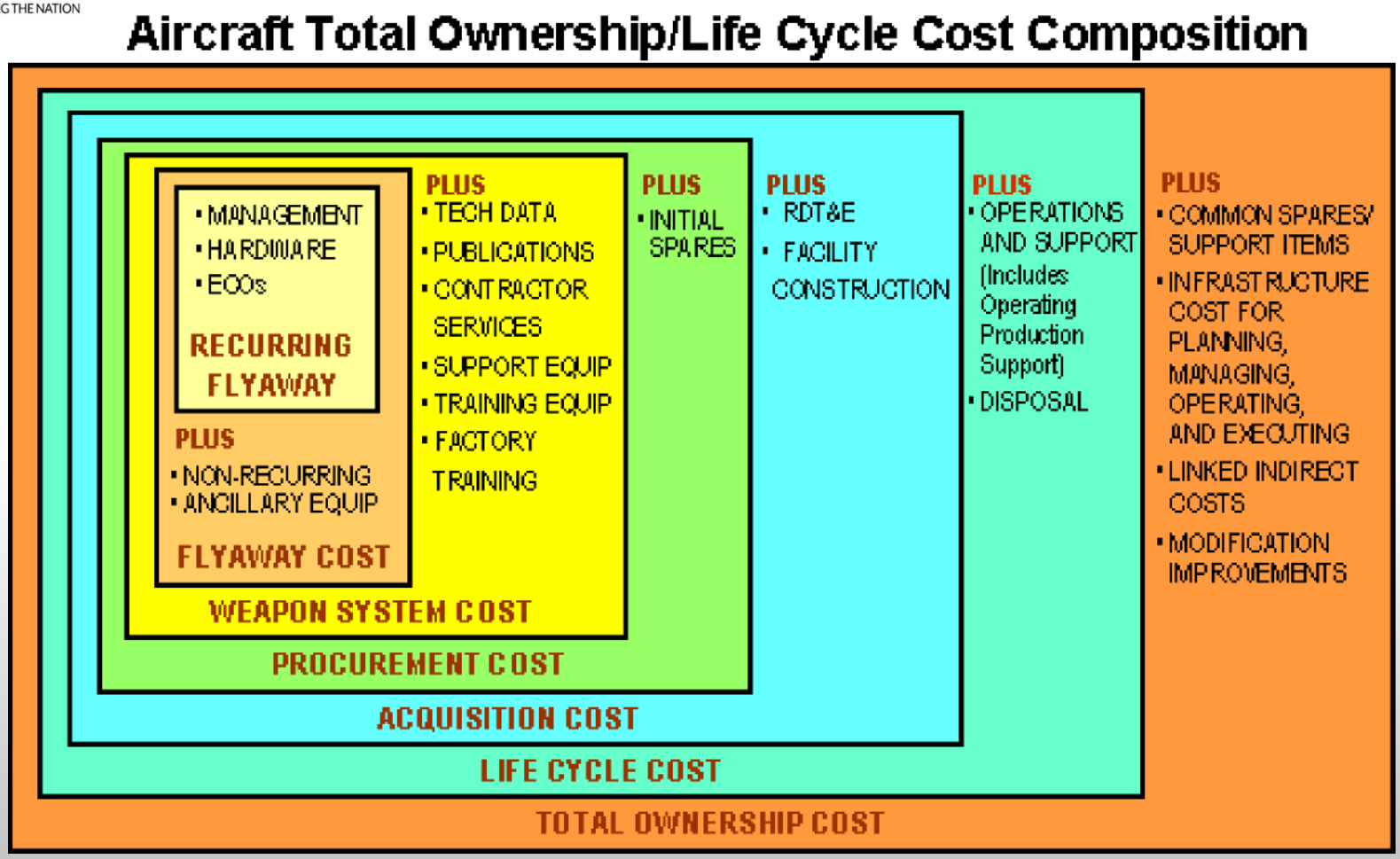
Other

- Rough Order of Magnitude (ROM)
- Independent Cost Assessment (ICA)
- Independent Government Cost Estimate (IGCE)
- Estimate at Completion (EAC)

Main difference between LCCEs and BCAs is the number of alternatives estimated and output format.

Background

Life Cycle Cost Versus Total Ownership Cost



Unit Cost Definitions Defined In Module #4

Background

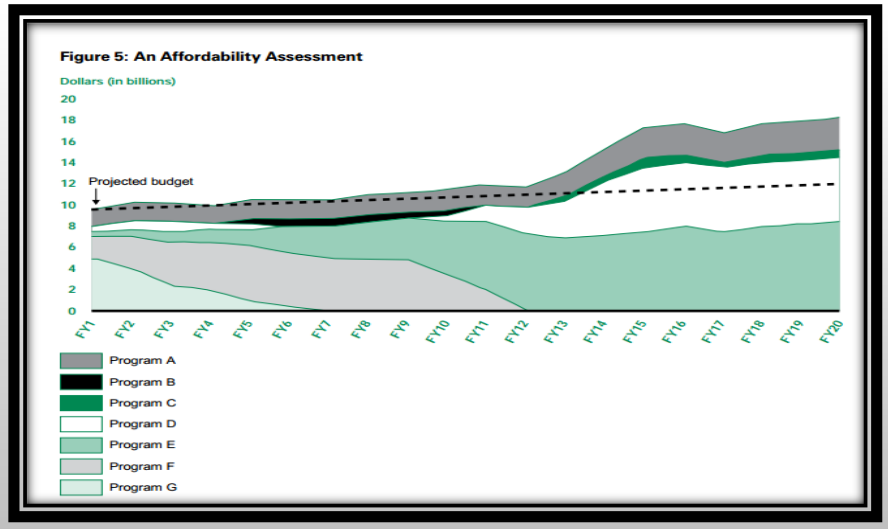
Qualities of a Good Cost Estimate

Quality	Definition
Comprehensive	Ensures that the estimate covers all cost elements in the program baseline while double counting none, and, that the estimate covers all elements in any excursions to the baseline.
Accurate	Ensures that the cost model is mathematically sound, or error free, and that the cost estimate is neither biased upward nor downward, in terms of both the point estimate and its associated probability distribution.
Credible	Ensures that the estimate meets stakeholder requirements; maximizes the use of scientifically-sound principles while minimizing subjectivity; tests and revisits assumptions; and assesses risk and uncertainty.
Well Documented	Ensures that the estimate is completely documented, including data sources, methodology, and ground rules and assumptions. This ensures the estimate can be duplicated by another analyst(s).

Background

Cost Analysis and Affordability

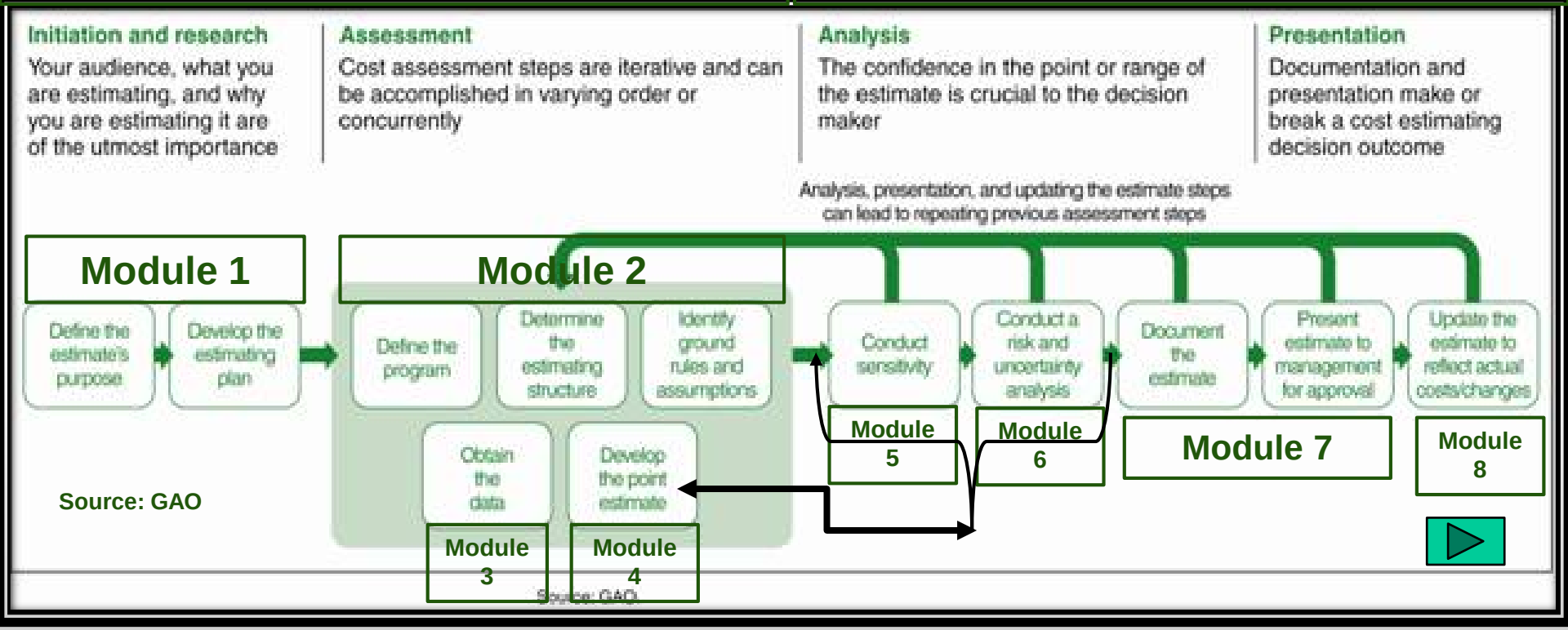
- Affordability is degree to which an acquisition program's funding requirements fit within the agency's overall "portfolio" plan.
- Realistic cost estimates are an important part of the affordability analysis
- Affordability analysis is an iterative process
  - Beginning and end of each TOC
  - At each Milestone
  - Between each Milestone and budget cycle
- How many people have ever bought a car?



Attend MORS Affordability tutorial for more information

Background
12 Steps of Estimating Process

Intro to Cost Estimation, Part I | **Intro to Cost Estimation, Part II**



This is the general OR process with $$ vice airplanes, tanks, ships or other in it. Don't be timid about cost estimating!

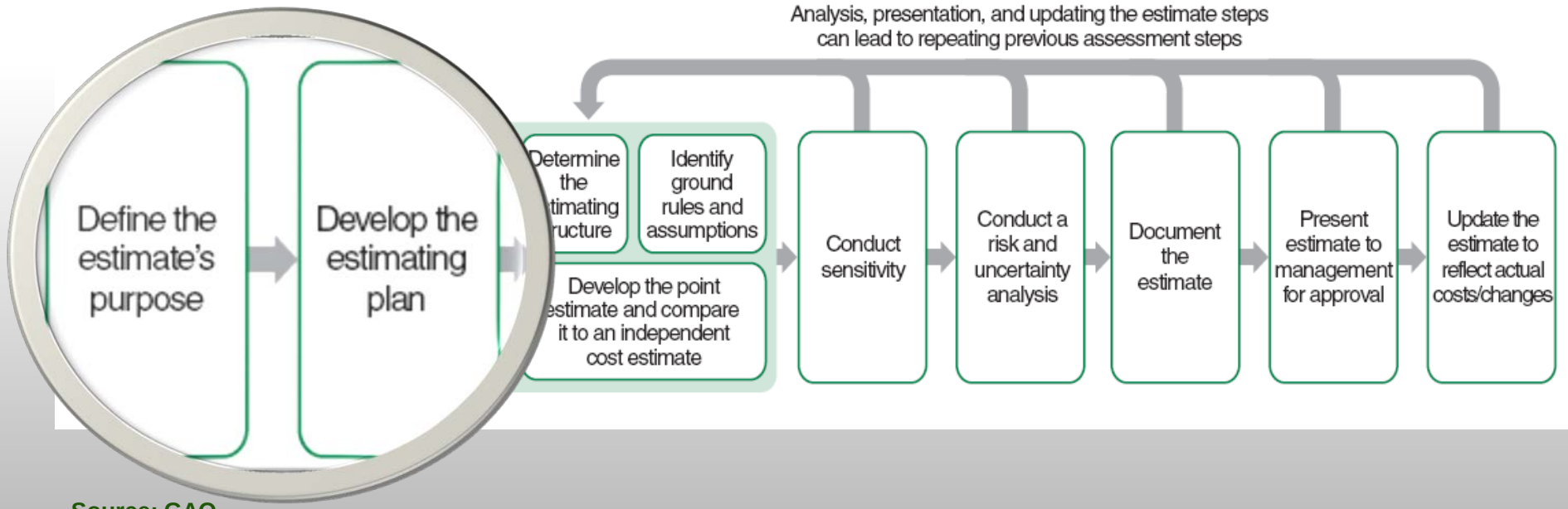
Phase 1: Initiation And Research Steps One and Two

Initiation and research
Your audience, what you are estimating, and why you are estimating it are of the utmost importance

Assessment
Cost assessment steps are iterative and can be accomplished in varying order or concurrently

Analysis
The confidence in the point or range of the estimate is crucial to the decision maker

Presentation
Documentation and presentation make or break a cost estimating decision outcome



Source: GAO

Step 1: Define the Estimate's Purpose

Purpose

- Determined by the customer's needs and intended use determines scope and detail
- Cost estimates have two general purposes:

  1. Help decision managers evaluate affordability and performance against plans, and selection of alternative systems and solutions (Business Case Analysis)

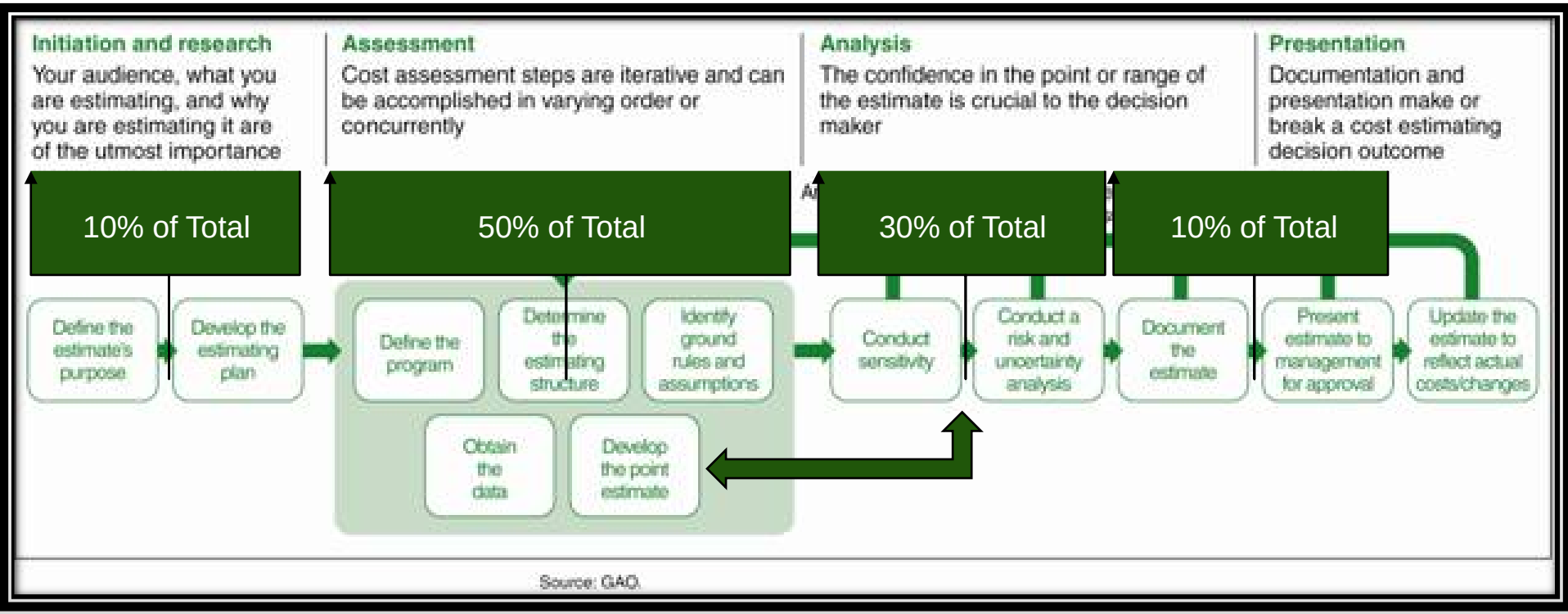
  2. Support the budget process by providing estimates of the funding required to efficiently execute a program (Life Cycle Cost Estimate)
- A program's purpose should relate to agency missions, goals, and objectives
  - The estimate's purpose should address benefits and performance measures
- Determine who will receive the estimate and the stakeholders involved

Step 1: Define the Estimate's Purpose
Scope

- Cost analysts must identify customer's need
  - Government – Joint Capabilities Integration Development System (JCIDS), Operational Requirements Document (ORD), Mission Needs Statement (MNS), Cost Analysis Requirements Description (CARD), Cost Analysis Data Requirement (CADRE), or Cost Estimating Baseline Document (CEBD) etc.
  - Contractor: Negotiate in Statement of work (SOW)
- Determine how many of the twelve steps are required
- Life Cycle Cost Estimates
  - Determine which or all of the Phases you are required to estimate (EMD, Procurement, Military Construction, Operations & Support, and Disposal)
  - Determine Life Cycle Cost Estimate (LCCE) versus Total Ownership Cost (TOC)
- Business Case Analysis
  - Determine rough estimate of alternatives (may get good idea form requirements documents)
  - Determine if all elements need to estimated or just major cost drivers and different cost elements across all alternatives (Will this be used for customer's LCCE?)

Step 1: Define the Estimate's Purpose

Schedule Overview (Percent of Overall Effort for 11 Steps)



Percentage of time based on numerous years of experience, no data to support this, but good rules of thumb.

Step 1: Define the Estimate's Purpose
Schedule Overview (Detailed)

1. Create detailed schedule that includes key decision points.
    1. Recommend major Milestones to include at the minimum the end of the four phases
    2. Peer, SME, and management review is critical
    3. Recommend project tool for scheduling using recommended resources from your corporation

Step 2: Develop the Estimating Plan
Team Composition and Organization

- Life Cycle Cost Estimate
  - Total Ownership Cost
    - Multidisciplinary teams to include various skills
    - Large team (average 3 to 6), many months to complete
  - Independent Cost Estimate
    - Focused effort of cost analysts, interaction with various disciplines
      - Small team (average 1 to 3), about six months to complete
- Business Case Analysis
  - Multidisciplinary teams to include various skills
  - Large team (average 3 to 6), many months to complete
- Other
  - Smaller and more focused efforts

Step 2: Develop the Estimating Plan

Outline the Estimating Approach

1. Develop Work Breakdown Schedule (WBS)
2. Determine areas of WBS to estimate
3. Develop methodology for those WBS items
4. Results is Cost Estimating Methodology Matrix (CEMM)

WBS	Methodology	Data Source(s)
1.0 Aircraft System	Sum of below	
1.1 Air Vehicle	Sum of below	
1.1.1 Airframe	Analogy to Program A, adjusted for complexity	Actuals from Cost and Software Data Reporting (CSDRs) CSDRs (1921-1) from Program A
1.1.2 Propulsion	Parametric of weight and range based on similar fixed wing aircraft	1. Actuals CSDRs (1921-1) of similar fixed wing aircraft 2. Weight and range from CARD

Initial planning only, detailed analysis in Step 4 of Module Two.

Step 2: Develop the Estimating Plan

Develop the Estimating Timeline

1. Take the final deliverable date and work your way backwards
2. Look at the 12 steps and decide which ones are required
3. Build those selected steps into smaller milestones and set reviews with customers and stakeholders.

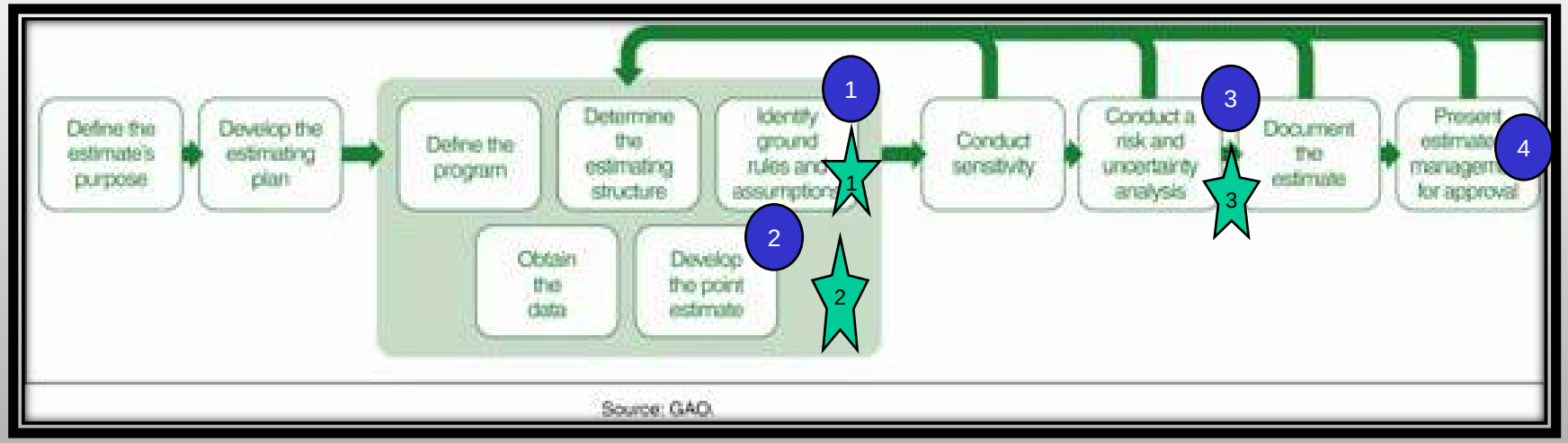
Step 2: Develop the Estimating Plan

Develop the Estimating Timeline (Example)

Steps 1 through 11 (TOC)

- Project duration is two years (24 months)
- Starting from scratch
- ACAT I Navy Electronic program
- Two to three FTEs

- **Reviews with Customer/Stakeholders** #
  1. Initial Review
  2. Middle Review
  3. Final Review
- **Deliverables** #
  1. Study Plan (within two months)
  2. Draft Baseline Model (within 15 months)
  3. Completed Model with Excursions, Sensitivity, and Uncertainty (within 22 months)
  4. Documentation and Presentation(s) (within 24 months)
     - **Document while doing baseline model, excursions, and uncertainty**



How First Two Steps fit into Different Types of Estimates? (LCCEs and BCAs)

- Purpose
  - To build a budget quality estimate or determine best alternative or path forward
- Scope
  - Anticipate all the steps
  - Consists of all elements of life cycle costs plus shared infrastructure and other business practices
- Schedule
  - Many months to years to complete
- Estimating Plan
  - Build with incremental reviews and deliverables

Summary
Best Practices Checklist (Overall)

- ❑ The cost estimate type is clearly defined and is appropriate for its purpose.
- ❑ The cost estimate contains all elements suitable to its type—ICA, ICE, IGCE, LCCE, rough order of magnitude, total ownership cost: development, procurement, operating and support, disposal costs, and all sunk costs.
  - ✓ AOA, CEA, EA, cost-benefit analysis: consistently evaluate all alternatives.
  - ✓ EA, cost-benefit analysis: portray estimates as present values.
- ❑ All program costs have been estimated, including all life-cycle costs.
- ❑ The cost estimate is independent of funding source and appropriations.
- ❑ An affordability analysis has been performed at the agency level to see how the program fits within the overall portfolio.
  - ✓ The agency has a process for developing cost estimates that includes the 12-step best practice process outlined in next slide
  - ✓ An overall agency portfolio sand chart displays all costs for every program.
- ❑ The estimate is updated as actual costs become available from the EVM system or requirements change.
- ❑ Post mortems and lessons learned are continually documented.

Source: GAO

Best Practices Checklist #1

Estimate Purpose and Scope

- ❑ The estimate's purpose is clearly defined.
- ❑ Its scope is clearly defined.
- ❑ The level of detail the estimate is to be conducted at is consistent with the level of detail available for the program. For example, an engineering build-up estimate should be conducted only on a well-defined program.
- ❑ The team has been allotted adequate time and resources to develop the estimate.

Source: GAO

Best Practices Checklist #2

Develop the Estimating Plan

- ❑ The estimating team's composition is commensurate with the assignment
  - ✓ The team has the proper number and mix of resources.
  - ✓ Team members are from a centralized cost estimating organization.
  - ✓ The team includes experienced and trained cost analysts. (May add untrained, if you have designated mentors)
  - ✓ The team includes, or has direct access to, analysts experienced in the program's major areas.
  - ✓ Team members' responsibilities are clearly defined.
  - ✓ Team members' experience, qualifications, certifications, and training are identified.
  - ✓ The team participated in on-the-job training, including plant and site visits.
- ❑ A master schedule with a written study plan has been developed.

Source: GAO

Review of Learning Objectives

1. Understand the Different Types of Estimates and how Life Cycle Cost Estimates (LCCEs) and Business Case Analysis (BCAs) fits into this process
2. Understand the 12 steps of the Cost Estimating Process and How This Relates to the OR Process
3. Understand how to properly define an estimate's purpose and plan

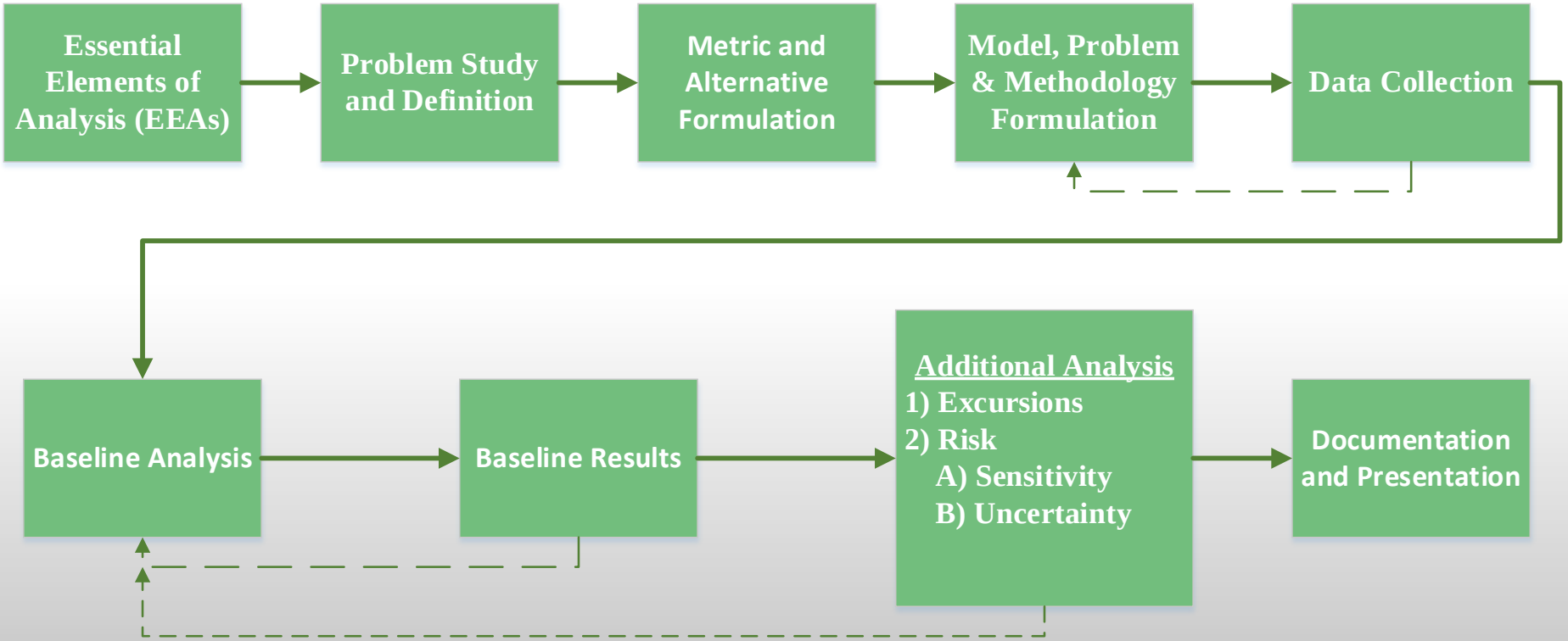
Backup

…In the Cost Guide

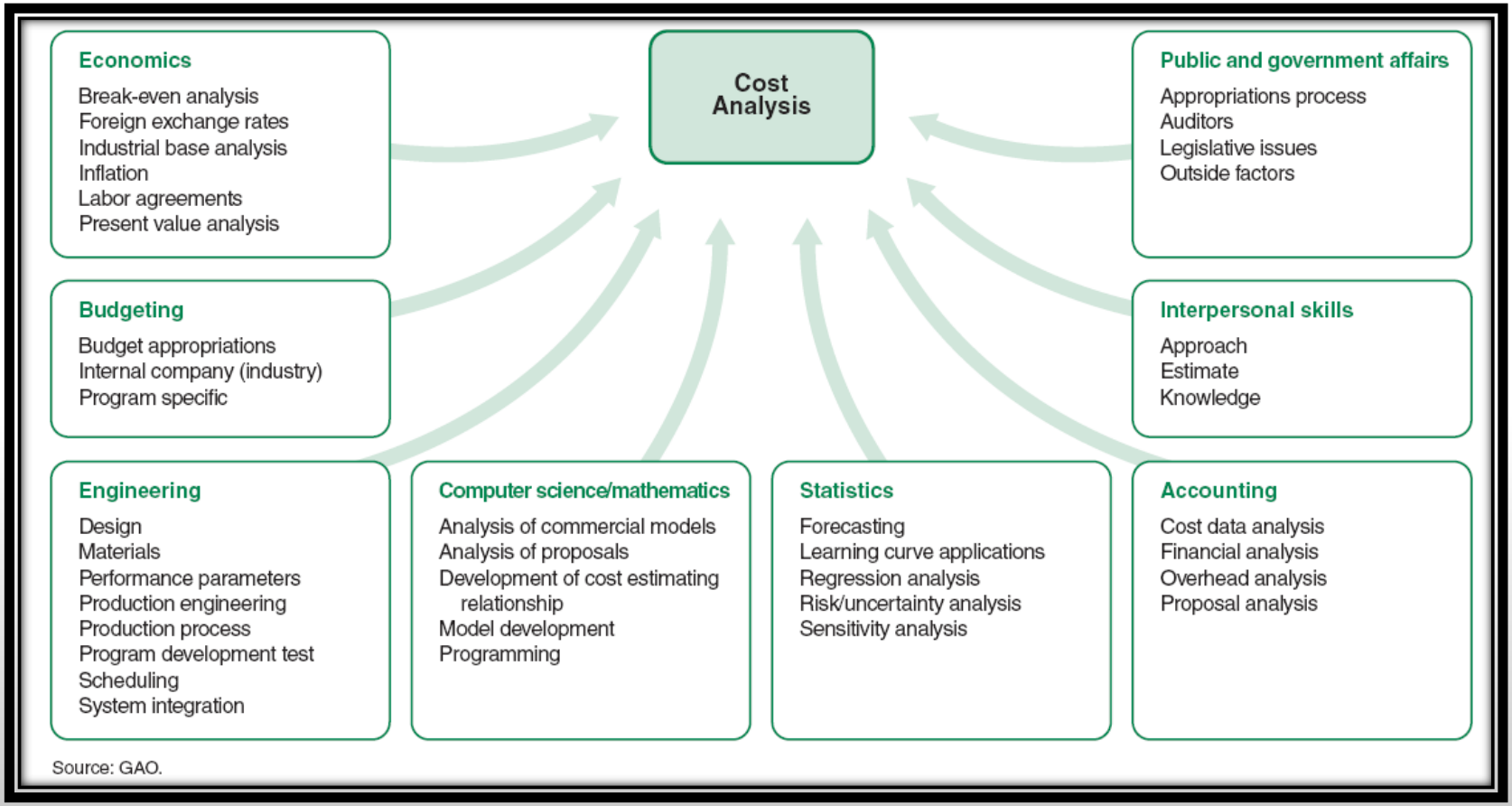
Step	Description	Cost Guide Chapter	Phase in Process
1	Define estimate's purpose	5	Initiation & Research
2	Define estimate's plan	5, 6	Initiation & Research
3	Define program characteristics	7	Assessment
4	Determine estimating structure	8	Assessment
5	Identify GR&As	9	Assessment
6	Obtain data	10	Assessment
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

Source: GAO

General OR Process



Cost Estimating Team's Experience



- Consider dividing up work by phases, if enough resources available
- Designate person to integrate with non-cost, if working BCAs

Details on Good Study Plan

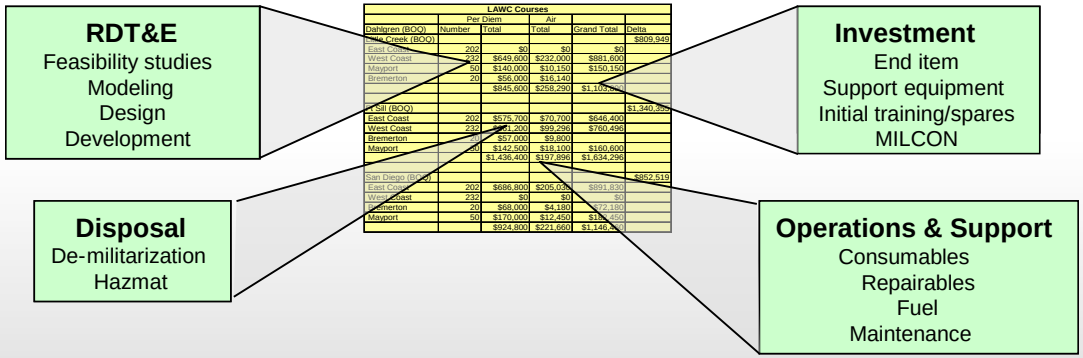
Example AoA Outline

1. Background
2. Mission Needs
3. Program Status
4. Overarching Principles of the Study
   - 4.1 Study Objective
   - 4.2 Scope of Analysis
   - 4.3 Overarching Ground Rules and Assumptions
   - 4.4 Study Oversight
   - 4.5 Governing Guidance and References
5. Analysis Elements
   - 5.1 Introduction
   - 5.2 Alternatives
     - 5.2.1 Baseline
     - 5.2.2 Baseline Plus
     - 5.2.3 Other Existing Capabilities or New Technology
   - 5.3 Exploratory Analysis
     - 5.3.1 Methodology
     - 5.3.2 Screening Criteria
   - 5.4 Evaluation Analysis
     - 5.4.1 Mission Tasks, Measures of Effectiveness, Measures of Performance
     - 5.4.2 Mission Effectiveness
     - 5.4.3 Cost/Affordability
6. Cost – Effectiveness Synthesis
   - 6.1 Introduction
   - 6.2 Synthesis Process
7. Final Report Format
8. Schedule and Deliverables
9. List of References
10. List of Acronyms

Life Cycle Cost Estimates

Estimation is an iterative process.

- The estimate becomes more refined as the program progresses towards and into production
  - The specific information on the yellow cost estimate shown here is not important
  - What is important are the components of the estimate (mentioned later): RDT&E, Investment, Operations & Support, and Disposal

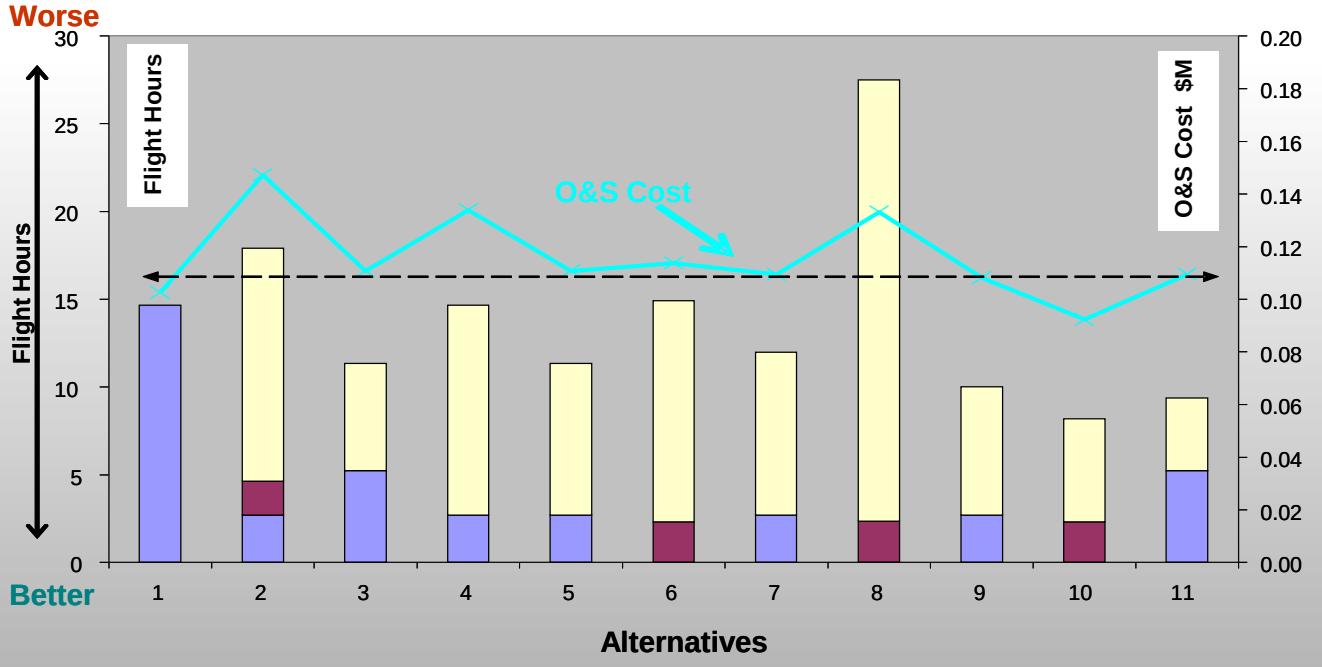


- The first step is to determine relevant cost elements to consider
  - The scope/level of detail will vary by acquisition phase and type of program
- A model must then be constructed or selected
  - Model must be recognized as valid
  - DOD Acquisition Logistics Guide catalogues various types
    - Example: Cost Analysis Strategy Assessment Model (CASA)
  - Analyst must understand model's assumptions, approach, and drivers

Business Case Analysis Process

Analysis of Alternatives (AoAs)

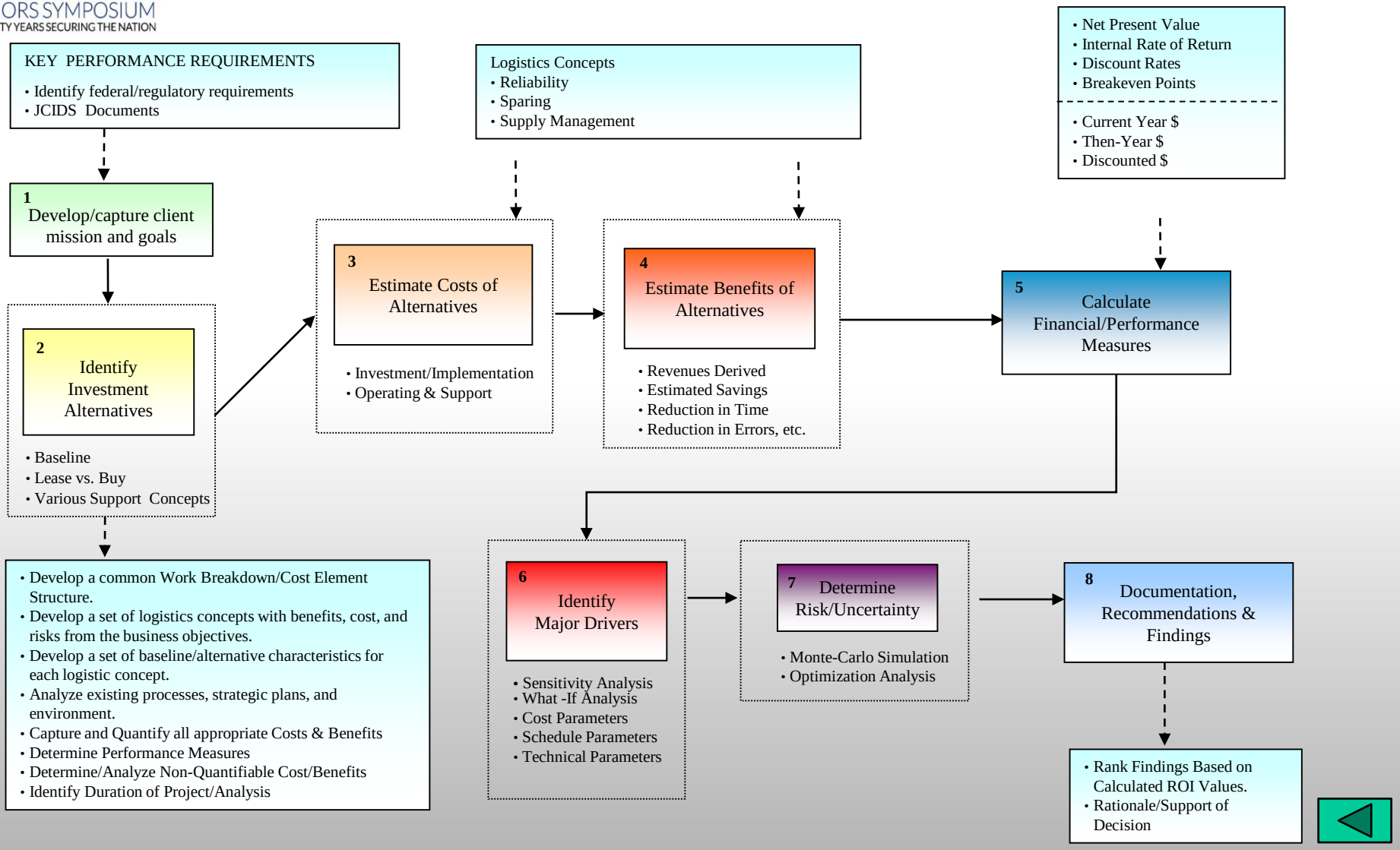
- Define Alternatives
- Define Measures Each Alternative Will Be Evaluated Against
- Calculate LCC/TOC (**using Net Present Value**) to Accomplish Measure
- Compare Effectiveness versus Cost
  - Effective and Cost Vary for each alternative (see below)
  - Fix Effectiveness and Calculate Cost
  - Fix Cost and Calculate Effectiveness



- **Similar cost to execute majority of cases**
- **Case 10 most efficient and lowest cost to execute**
  - **Requires upgrades and low threat**
- **Operating cost are comparable for Cases 3, 5, 7, 9, 11**

Business Case Analysis Process

Economic Analysis (EA)



How First Two Steps fit into Different Types of Estimates? (Other)

- Purpose
  - Varies with type of estimate
  - Anticipate a subset of the 12 steps
  - Focus on only relevant cost elements
- Schedule
  - Days to months to complete
- Estimating Plan
  - Varies with type of estimate