Defense Acquisition

Guidebook Chapter 3 - Affordability and Life-Cycle Resource Estimates

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DEFENSE ACQUISITION GUIDEBOOK
Chapter 3-- Affordability and Life-Cycle Resource Estimates

3.0. Overview

3.0.1. Purpose

This chapter addresses acquisition program affordability and resource estimation. It provides explanations of the Office of the Secretary of Defenses Office of Cost Assessment and Program Evaluations (CAPEs) policies and procedures as well as information required by DoD Instruction 5000.02, *Operation of the Defense Acquisition System*. DoD Instruction 7000.14 establishes DoD 7000.14-R as the DoD-wide financial management regulation (FMR) to be used by all DoD Components for accounting, budgeting, finance, and financial management education and training. The link to the FMR is provided as a convenience to the reader.

3.0.2. Contents

Section 3.1 provides introductory background material intended for a general audience. It describes the concept of program life-cycle cost, and provides definitions of terms used by the DoD cost community. It also introduces the concepts of total ownership cost and fully burdened cost of delivered energy.

The next five sections are more specialized; they discuss the specific milestone review procedures, expectations, and best practices for a variety of topics related to acquisition program affordability, cost, and manpower:

Section 3.2 describes the basic policies associated with the consideration of affordability in the acquisition process and offers parameters for preparing affordability analyses and constraints on investments. This section also explains the Department's full-funding policy.

Section 3.3 describes the Analysis of Alternatives process.

Section 3.4 describes the role of both DoD Component cost estimates and independent cost estimates in support of the DoD acquisition system.

Section 3.5 describes the review procedures for manpower estimates.

Section 3.6 discusses procedures unique to economic analyses of major automated information systems.

Section 3.7 is intended for less experienced cost analysts working in the acquisition community. This section, which is tutorial in nature, provides a recommended analytic approach for preparing a life-cycle cost estimate for a defense acquisition program.

3.1. Life-Cycle Costs/Total Ownership Costs

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3.1.1. Introduction

Both DoD Directive 5000.01, *The Defense Acquisition System*, and DoD Instruction 5000.02, *Operation of the Defense Acquisition System*, make reference to life-cycle cost and total ownership cost. This section of the Guidebook explains the meaning for each of these terms. The terms are similar in concept but somewhat different in scope and intent. For a defense acquisition program, life-cycle cost consists of research and development costs, investment costs, operating and support costs, and disposal costs over the entire life cycle. These costs include not only the direct costs of the acquisition program but also indirect costs that would be logically attributed to the program. In this way, all costs that are logically attributed to the program are included, regardless of funding source or management control.

The concept of total ownership cost is related but broader in scope. Total ownership cost includes the elements of life-cycle cost as well as other infrastructure or business process costs not normally attributed to the program. Section 3.1.5 defines and describes this concept in more detail.

Program cost estimates that support the defense acquisition system normally are focused on life-cycle cost or elements of life-cycle cost. Examples of cases where cost estimates support the acquisition system include affordability analyses, establishment of program cost goals for Acquisition Program Baselines, independent cost estimates, or estimates of budgetary resources. However, for programs that are pre-Milestone A or in the Engineering and Manufacturing Development Phase, cost estimates that are used within the program office to support system trade-off analyses, such as evaluations of design changes or assessments of energy efficiency, reliability, maintainability, and other supportability considerations, may need to be broader in scope than traditional life-cycle cost estimates to support the purpose of the analyses being conducted. Moreover, for mature programs (in transition from production and deployment to sustainment), cost estimates may need to be expanded in scope to embrace total ownership cost concepts in order to support broad logistics or management studies.

3.1.2. Life-Cycle Cost Categories and Program Phases

3.1.3. Life-Cycle Cost Category Definitions

3.1.3.1. Research and Development Costs

3.1.3.2. Investment Costs

3.1.3.3. Operating and Support (O&S) Costs

3.1.3.4. Disposal Costs

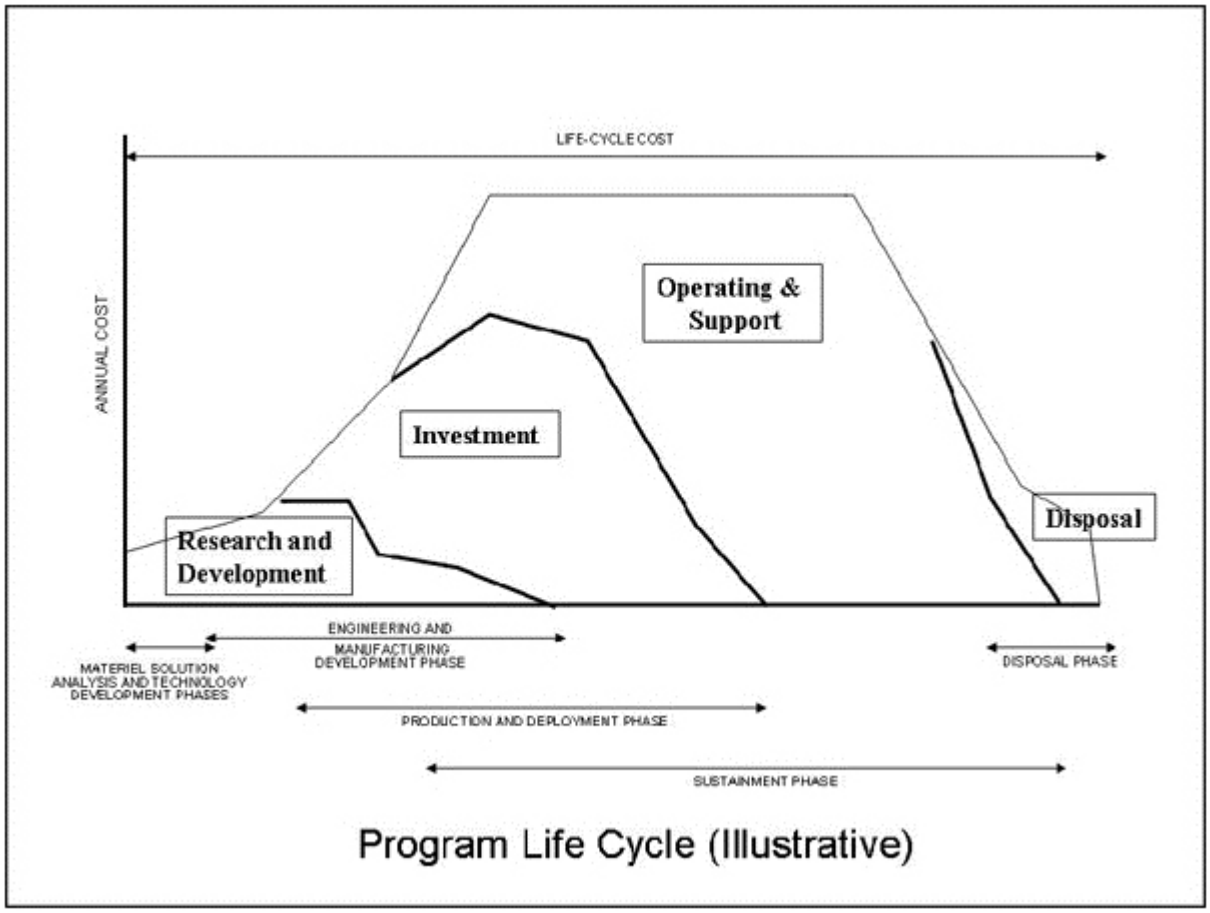
3.1.2. Life-Cycle Cost Categories and Program Phases

DoD 5000.4-M, *DoD Cost Analysis Guidance and Procedures*, provides the DoD definitions of cost terms used in describing system life-cycle costs. Life-cycle cost is the sum of the following four major cost categories, where each category is associated with sequential but overlapping phases of the program life cycle:

1. Research and development costs associated with the Materiel Solution Analysis phase, the Technology Development phase, and the Engineering and Manufacturing Development phase;
2. Investment costs associated with the Production and Deployment phase;
3. Operating and support costs associated with the sustainment phase; and
4. Disposal costs occurring after initiation of system phase out or retirement, possibly including demilitarization, detoxification, or long-term waste storage.

Figure 3.1.2.F1 depicts a notional profile of annual program expenditures by cost category over the system life cycle.

Figure 3.1.2.F1. Illustrative Program Life Cycle



3.1.3. Life-Cycle Cost Category Definitions

The following sections summarize the primary cost categories associated with each program life-cycle phase.

3.1.3.1. Research and Development Costs

Research and Development consists of development costs (both contractor and government) incurred from the beginning of the materiel solution analysis phase through the end of the Engineering and Manufacturing Development (EMD) Phase (excluding costs associated with Low-Rate Initial Production). This typically includes costs of materiel solution trade studies and advanced technology development; system design and integration; development, fabrication, assembly, and test of hardware and software for prototypes and/or engineering development models; system test and evaluation; systems engineering and program management; and product support elements associated with prototypes and/or engineering development models.

Research and Development costs are estimated and presented using the following categories:

Materiel Solution Analysis Phase

Technology Development Phase [Note: For programs with extensive prototyping and/or preliminary design activities that occur before Milestone B, the Technology Development Phase should be expanded with lower level cost categories, similar to the categories used in the EMD Phase]

Engineering and Manufacturing Development Phase:

- Prime Mission Product
- System Test and Evaluation
- Systems Engineering/Program Management
- Engineering Change Orders
- Peculiar Support Equipment
- Common Support Equipment
- Training
- Technical Publications and Data
- Initial Spares and Repair Parts
- Industrial Facilities
- Operational/Site Activation

Complete definitions and further details are provided throughout MIL-STD-881C, *Work Breakdown Structures for Defense Materiel Items*. Note the following:

- The Standard expands the Prime Mission Product category into more detailed elements. These lower level elements vary by product commodity (such as aircraft, electronic system, missile system, sea system, or surface vehicle).
- Supportability analysis that defines the requirements for the logistics elements is part of Systems Engineering and planning and management associated with the logistics elements is part of Program Management.
- In most cost estimates, the Engineering Change Orders element is added to the Standard taxonomy to allow a contingency for design or other scope changes.
- In most cost estimates, the first four EMD elements shown above are subtotaled and displayed as Flyaway, Rollaway, Sailaway, or other similar term. The remaining EMD elements are often grouped together and labeled as "Acquisition Logistics," "Product Support Package," or other similar term.
- The Training element includes training equipment and devices, training course materials, and training services.
- Specialized facilities (fixtures, test chambers, laboratories, etc.) are considered part of the Work Breakdown Structure (WBS) element that they support. General brick and mortar type facilities are part of the Industrial Facilities element.
- Specialized contractor support is considered part of the WBS element that it supports. Contractor support associated with the service, maintenance or launch of prime mission systems is part of the Operational/Site Activation element.

An abbreviated version of the above format is used in Budget Exhibit R-3, RDT&E Project Cost Analysis, to display budget justifications and financial reporting for Research, Development, Test and Evaluation projects with budgets greater than $1 million in either budget year. *See* DoD 7000.14 R, Financial Management Regulation, Volume 2B, Chapter 5.

3.1.3.2. Investment Costs

Investment consists of production and deployment costs incurred from the beginning of low rate initial production through completion of deployment. This typically includes procurement costs associated with producing and deploying the primary hardware, systems engineering and program management, product support elements associated with production assets, military construction, and operations and maintenance associated with the production and deployment phase.

Investment costs are estimated and presented using the following categories:

Procurement

Prime Mission Product

System Test and Evaluation (if applicable)

Systems Engineering/Program Management

Engineering Change Orders

Peculiar Support Equipment

Common Support Equipment

Training

Technical Publications and Data

Initial Spares and Repair Parts

Industrial Facilities

Operational/Site Activation

Military Construction

Operations and Maintenance (acquisition-related during production and deployment)

Complete definitions and further details for the Procurement elements are provided throughout MIL-STD-881C, *Work Breakdown Structures for Defense Materiel Items*. Note the following:

- The Standard expands the Prime Mission Product category into more detailed elements. These lower level elements vary by product commodity (such as aircraft, electronic system, missile system, sea system, or surface vehicle).
- Supportability analysis that defines the requirements for the logistics elements is part of Systems Engineering, and planning and management associated with the logistics elements is part of Program Management.
- In most cost estimates, the Engineering Change Orders element is added to the Standard taxonomy to allow a contingency for design or other scope changes.
- In most cost estimates, the first four procurement elements shown above are subtotaled and displayed as Flyaway, Rollaway, Sailaway, or other similar term. The remaining procurement elements are often grouped together and labeled as "Acquisition Logistics," "Product Support Package," or other similar term.
- The Training element includes training equipment and devices, training course materials, and training services.
- Specialized facilities (fixtures, test chambers, laboratories, etc.) are considered part of the Work Breakdown Structure (WBS) element that they support. General brick and mortar type facilities are part of the Industrial Facilities element.
- Specialized contractor support is considered part of the WBS element that it supports. Contractor support associated with the service, maintenance or launch of prime mission systems is part of the Operational/Site Activation element.

An abbreviated modified version of the above format (procurement only) is used in Budget Exhibit P-5, Cost Analysis, to display budget justifications and financial reporting for procurement programs with budgets greater than or equal to $5 million in either budget year. (See DoD 7000.14 R, Financial Management Regulation, Volume 2B, Chapter 4.)

3.1.3.3. Operating and Support (O&S) Costs

O&S consists of sustainment costs incurred from the initial system deployment through the end of system operations. This includes all costs of operating, maintaining, and supporting a fielded system. Specifically, this consists of the costs (organic and contractor) of manpower, equipment, supplies, software, and services associated with operating, modifying, maintaining, supplying, training, and supporting a system in the DoD inventory. This includes costs directly and indirectly attributable to the system (i.e., costs that would not occur if the system did not exist), regardless of funding source or management control. Direct costs refers to the resources immediately associated with the system or its operating unit. Indirect costs refers to the resources that provide indirect support to the system (including its manpower or facilities). For example, the pay and allowances for a unit-level maintenance technician would be treated as a direct cost, but the cost of medical support for the same technician would be an indirect cost.

Operating and Support costs are estimated and presented using the following categories:

Unit-Level Manpower

Operations Manpower

Unit-Level Maintenance Manpower

Other Unit-Level Manpower

Unit Operations

Operating Materiel

Energy (Fuel, Electricity, etc.)

Training Munitions and Expendable Stores

Other Operational Materiel

Support Services

Temporary Duty

Maintenance

Organizational Maintenance and Support

Intermediate Maintenance

Depot Maintenance

Sustaining Support

System Specific Training

Support Equipment Replacement

Operating Equipment Replacement

Sustaining Engineering and Program Management

Other Sustaining Support

Continuing System Improvements

Hardware Modifications or Modernization

Software Maintenance and Modifications

Indirect Support

Installation Support

Personnel Support

General Training and Education

Further details and complete definitions are provided in the Operating and Support Cost-Estimating Guide promulgated by the Director, Cost Assessment and Program Evaluation.

3.1.3.4. Disposal Costs

Disposal costs are the costs associated with demilitarization and disposal of a military system at the end of its useful life. Depending upon the characteristics of the system, demilitarization and disposal costs may be significant, so it is important to consider the costs early in the systems life cycle. Costs associated with demilitarization and disposal

include disassembly, materials processing, decontamination, collection/storage/disposal of hazardous materials and/or waste, safety precautions, and transportation of the system to and from the disposal site. Systems may be given credit in the cost estimate for resource recovery and recycling considerations.

The disposal cost category is intended to be used to ensure that design and other decisions made early in the program consider their effects on the specific long-term disposal costs that can be logically attributed to the program. Disposal costs of a more general nature, such as the removal of unexploded ordnance at a training range, would normally not be attributed to a specific aircraft program that in the future may participate in training exercises at that range.

Disposal costs may be estimated and presented using the following categories, subject to tailoring for the circumstances unique to each program:

Removal from Active Service

Demilitarization

Removal and Disposal of Hazardous Materials

Reclamation of Parts

Storage

Final Disposal or Salvage

3.1.4. Implications of Evolutionary Acquisition

3.1.5. Total Ownership Costs

3.1.6. Fully Burdened Cost of Delivered Energy

3.1.4. Implications of Evolutionary Acquisition

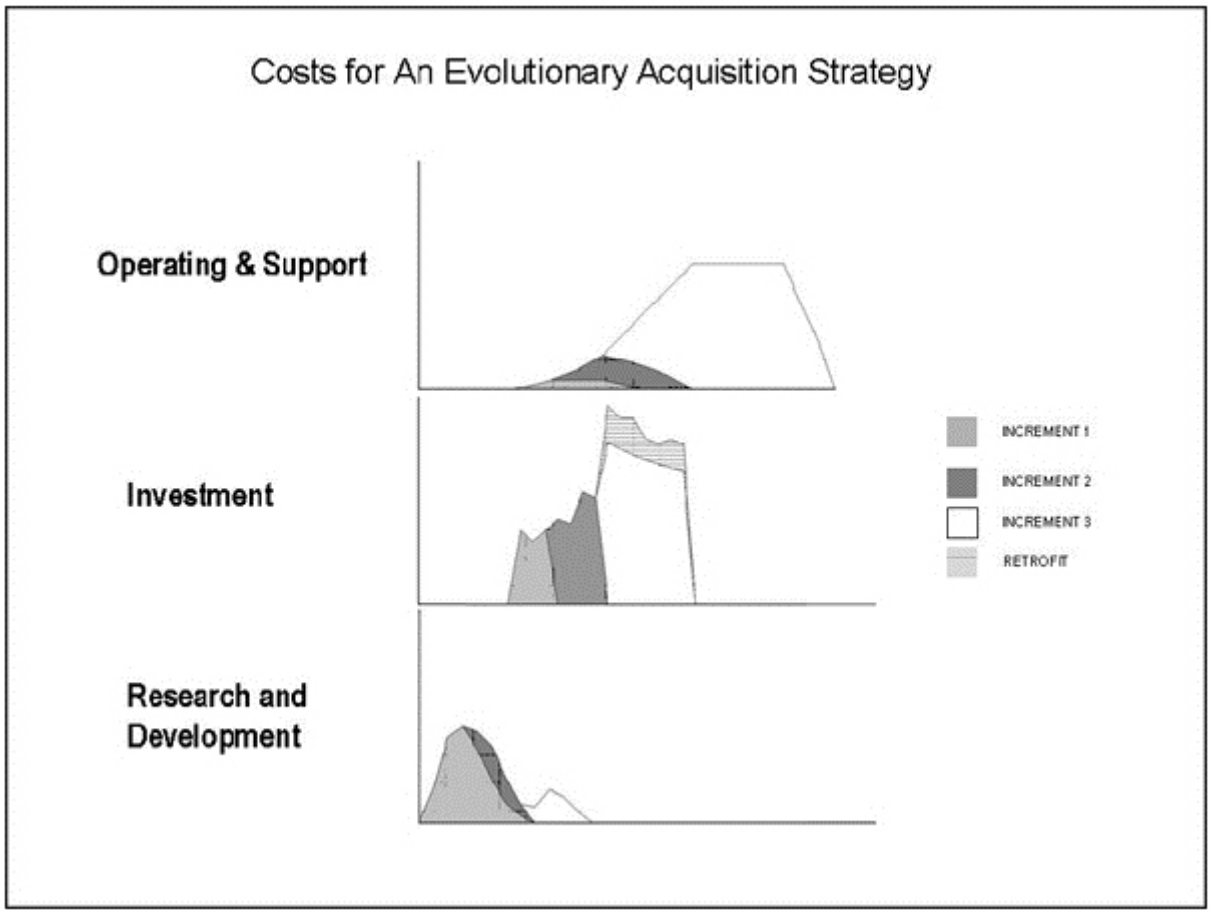
The application of life-cycle cost categories to program phases may need to be modified for programs with evolutionary acquisition strategies. DoD Instruction 5000.02, *Operation of the Defense Acquisition System*, Enclosure 2, paragraph 2, describes the evolutionary acquisition approach for acquisition programs. In an evolutionary approach, the ultimate capability delivered to the user is provided in increasing increments. Evolutionary acquisition strategies (1) define, develop, produce, and deploy an initial, militarily useful capability (Increment 1) based on proven technology, demonstrated manufacturing capabilities, and time-phased definition capabilities needs; and (2) plan

up front for subsequent development, production, and deployment of increments beyond the initial capability over time (Increments 2 and beyond).

For a program with evolutionary acquisition, a question often arises concerning the scope of the life-cycle cost estimate presented at a milestone review. Although the situation may vary somewhat depending on individual circumstances, the life-cycle cost estimate should attempt to address as much of the program, including known future increments, as can be defined at the time of the initial (Increment 1) milestone review. Any exclusions for portions of the program that cannot be defined at that time should be clearly identified.

The application of life-cycle cost categories and program phases (as described in Section 3.1.2) may need to be modified to account for the evolutionary acquisition strategy. Figure 3.1.4.F1 depicts a notional profile of annual program expenditures by cost category for a program with evolutionary acquisition.

Figure 3.1.4.F1. Illustrative Program Life Cycle under Evolutionary Acquisition



3.1.5. Total Ownership Costs

As explained earlier, total ownership cost includes the elements of a program's life-cycle cost as well as other related infrastructure or business processes costs not necessarily attributed to the program in the context of the defense acquisition system. 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 "school-house" training, personnel administration and benefits, and medical care), and support to military bases (installations and communications/information infrastructure).

In general, traditional life-cycle cost estimates are often adequate in scope to support the review and oversight of cost estimates made as part of the acquisition system. However, depending on the issue at hand, the broader perspective of total ownership cost may be more appropriate than the life-cycle cost perspective, which may be too narrow to deal with the particular context. As discussed previously, for a defense acquisition program, life-cycle costs include not only the direct costs of the program but also certain indirect costs that would be logically attributed to the program. In a typical life-cycle cost estimate, however, the estimated indirect costs would include only the costs of infrastructure support specific to the program's military manpower (primarily medical support and system-specific training) and the program's associated installations or facilities (primarily base operating support and facilities sustainment, restoration, and modernization).

Many other important support or infrastructure activities such as recruiting and accession training of new personnel, individual training other than system-specific training, environmental and safety compliance, contract oversight support from the Defense Contract Management Agency and the Defense Contract Audit Agency, and most management headquarters functions, are normally not considered in the scope of a traditional acquisition program life-cycle cost estimate. In addition, important central (i.e., wholesale) logistics infrastructure activities such as supply chain management are implicitly incorporated in a traditional life-cycle cost estimate. The costs associated with central logistics infrastructure activities are somewhat hidden because the costs are reflected in the surcharges associated with working capital fund arrangements and are not explicitly identified. However, there could easily be cases where explicit consideration of such infrastructure activities would be important and would need to be recognized in a cost estimate or analysis. Examples of such cases are cost analyses tied to studies of alternative system support concepts and strategies; reengineering of business practices or operations; environment, safety, and occupational health considerations; and competitive sourcing of major infrastructure activities. In these cases, the traditional life-cycle cost structure may not be adequate to analyze the issue at hand, and the broader total ownership cost perspective would be more appropriate.

For such instances, the typical life-cycle cost tools and data sources would need to be augmented with other tools and data sources more suitable to the particular issue being addressed.

One special case in which traditional life-cycle cost models and data sources need to be augmented is the inclusion of the fully burdened cost of delivered energy in trade-off analyses for certain tactical systems. This case is discussed in the next section.

3.1.6. Fully Burdened Cost of Delivered Energy

A Computational Framework for Acquisition Tradespace Analyses

Summary

In the acquisition process, the Fully Burdened Cost of Energy (FBCE) estimates the energy-related costs to sustain specific pieces of equipment, including procurement of energy, the logistics needed to deliver it where and when needed, related infrastructure, and force protection for those logistics forces directly involved in energy delivery. FBCE shall be applied in trade-off analyses conducted for all developmental Department of Defense (DoD) systems with end items that create a demand for energy in the battlespace. FBCE does not identify savings for programmatic purposes. It is an analytic input to the business case analysis designed to identify the difference in total energy-related costs among competing options. Consistent with Section 138c of title 10, United States Code, and DoDI 5000.02, FBCE estimates shall be made and reported for all acquisition category (ACAT) I and II systems that will demand fuel or electric power in operations and will be applied to all phases of acquisition beginning with the preparation of the Analysis of Alternatives (AoA). An FBCE estimate is also required as part of Total Ownership Cost (TOC) calculations. FBCE is not additive to Total Ownership Costs but rather is reported beside it. While TOC estimates are based on the total peace-time life of a system, FBCE estimates are based on short combat scenarios. They provide different but complementary insights.

Introduction

The energy required to field and sustain forces with current deployed systems poses significant operating costs and imposes several operational constraints on the larger force structure. First, growing logistics footprints can impede force mobility, flexibility, timing, and staging, especially for anti-access and irregular conflicts. Reducing the need for energy can have significant benefits for force deployability and the timeline of operations. Second, this logistics footprint presents a target for conventional, irregular, and catastrophic threats, creating demand for force protection and transportation forces. In the conflicts of the past decade, for example, adversaries have targeted U.S. fuel supply convoys, putting our forces and their missions at risk and redirecting combat power and dollars to fuel delivery.

Conversely, reducing system energy demand can make operational forces more agile and lethal by extending their range and reducing their dependence on logistics lines. These reductions can be achieved through different, better informed tradespace choices, design alternatives, technologies, and force structure concepts.

As outlined in the 2011 DoD Operational Energy Strategy, DoD is instituting procedures, frameworks, analytic tools and reporting requirements to better understand and manage how this energy demand affects force capability, vulnerability, and enterprise costs.

One of these frameworks, FBCE, is used to inform the acquisition tradespace by quantifying the per gallon price of fuel (or per kilowatt price of electricity) used per day for two or more competing materiel solutions. The FBCE estimate includes apportioned costs of the energy logistics forces needed to deliver and protect the fuel in a scenario. Calculating the FBCE gives DoD decision makers a way to more accurately consider the cost of a systems energy logistics footprint when making trades between cost, schedule, and performance. It has the added benefit of informing decisions on the size and focus of DoD investments in science and technology programs that affect the energy demands of the force such as engines and propulsion, light-weight structural and armor materials, power efficiency in electronics, mobile power production and distribution, and more innovative system design approaches.

FBCE includes the cost of the fuel itself and the apportioned cost of all of the fuel logistics and related force protection required beyond the Defense Logistics Agency-Energy (DLA Energy) point of sale. While most planning scenarios generally employ military forces for fuel delivery and protection, in some cases, contractor logistics and protection may be presumed. The cost estimation method is the same though the data sources required may vary. As a decision tool, FBCE is meant to inform technological and design choices as it is applied in requirements development, acquisition trades, and technology investments. Successful implementation will over time help DoD manage larger enterprise risks such as high and volatile fuel prices.

The FBCE is applied in trade-off analyses conducted for all deployable DoD systems with end items that create a demand for energy in the battlespace. This FBCE methodological guidance applies to ACAT I and II developmental systems as well as mid-life upgrade or modernization choices.

FBCE estimates shall be prepared concurrently with the AoA for each materiel solution being considered. The AoA should develop those estimates to sufficient fidelity to determine if the differences in energy demand and resupply costs are significant enough to meaningfully influence the final choice of alternatives. For developmental system with delivered energy requirements (i.e., most systems), the AoA shall examine alternative ways to reduce operational energy demand as a significant system capability factor. Even if FBCE does not significantly differ between alternatives, but shows sensitivity to change between sub-component or design choices within all alternatives, the Service sponsoring the program shall continue FBCE efforts after completion of the AoA to inform trades in the subsequent acquisition phases. This includes technology

development, systems engineering, and design decisions, or even to incentivize bidders to offer more efficient systems. In all cases, FBCE shall be developed for all alternatives remaining in the trade space at the end of the AoA and not just for the alternative favored/chosen by the Service sponsor.

FBCE has a wide range of applications beyond system design. For example, it can be used for site specific investments such as efficiency improvements at a contingency base to reduce fuel deliveries.

Commercial vehicles such as buses or cars used in support of routine fixed base operations normally should not be regarded as "deployable" and are addressed in other regulations and guidance.

Fully Burdened Cost of Energy Computational Framework

This section outlines a basic framework developed by the Office of the Assistant Secretary of Defense for Operational Energy Plans and Programs (OASD(OEPP)) and the Office of the Secretary of Defense (OSD), Cost Assessment and Program Evaluation (CAPE), to calculate the FBCE. This framework is oriented towards liquid fuels but extends to other forms of energy demands (e.g., fuel cells, hybrid-electric engines, and nuclear and solar energy sources). The specific analytic tools and methods to estimate FBCE are being refined within the analytic, acquisition and costing communities. This approach was informed by analytical work started by a Defense Science Board task force in 2001, applied by the Office of Program Analysis and Evaluation in 2006 and 2007 in a ground system case study, and revisited by OSD while assessing several major defense acquisition programs (MDAPs) and their approach to fuel issues. This framework is intended to give DoD Components flexibility in developing methodologies tailored to their various domains and force planning methods. Alternative methods or interpretations may be allowed, but DoD Components should consult iteratively with appropriate OSD offices, especially the OASD(OEPP) before delivering a final product at a milestone review or similar decision point.

Calculation of the FBCE differs from most other cost factors in two main ways. First, it is scenario-based. The FBCE analysis should be based upon a range of operational scenarios or use conditions from those specified in the programs AoA guidance or in the approved programs analysis base to ensure comparability within program tradespace discussions. Further, in order to estimate operationally realistic costs, all scenarios have to be of sufficient duration to account for demanded logistics and force protection. In addition, the FBCE calculation requires participation from Component force planning and analytic organizations to appropriately calculate the estimates. The appropriate organizations vary by Service.

There is no definitive, "correct" answer for a given systems FBCE estimate. However, DoD Components should present a realistic and analytically defensible scenario and cost elements. The proponent’s scenario assumptions for fuel logistics must be consistent with Service future force plans and Concepts of Operation. Consistency

enables the Services and DoD to evaluate their assumptions relative to strategy and doctrine and make better informed risk decisions. DoD Components should use existing analytic tools, planning data, and costing methodologies where possible to develop FBCE values. If Components find their analytic tools are inadequate to make the necessary estimates, Components should approach OASD(OEPP) at the earliest opportunity to help identify potential solutions.

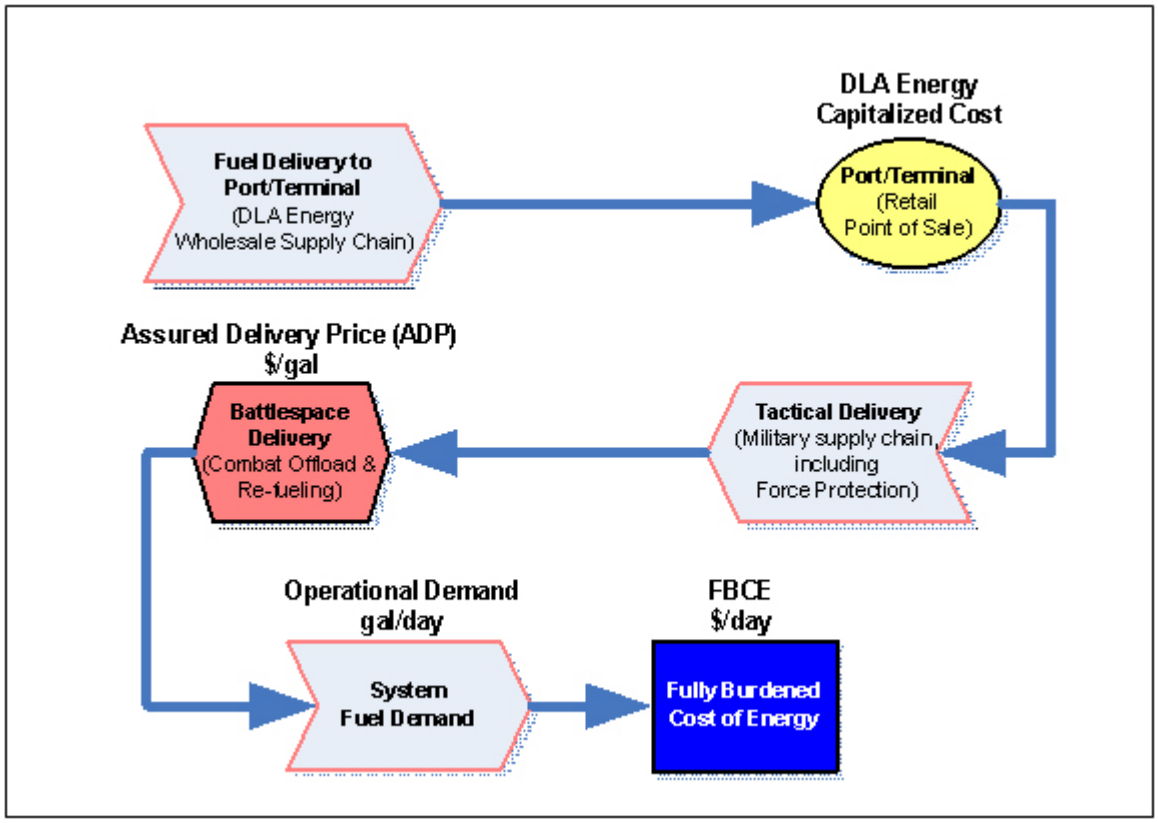
There are two key analytical components essential to developing a FBCE value:

1. **Scenarios.** Services decide upon a representative set of future operational scenarios or vignettes. However, to ensure the results of the FBCE calculations are comparable to other analytic measures, the same scenarios used in the programs AoA or analysis base shall be used in calculating the FBCE. The DoDs approved joint Defense Planning Scenarios (or Integrated Security Construct scenarios) and the Components supporting future force plans should provide the general guidance and analytic assumptions needed to identify appropriate scenarios. For purposes of computing the FBCE, scenarios must be of sufficient duration to require logistical re-supply of energy. Once the FBCE is calculated for the chosen scenarios, a simple mean average of the results will be computed.

2. **Apportionment.** Services determine what proportion of the fuel logistics footprint identified in the selected scenarios is attributable to the platform or system in question. Is it drawing 5% of the fuel from the fuel logistics units in the scenario or 20% or 50%? This percentage should inform how one attributes the logistics footprint to this one developmental system. Because no single system in any operation takes 100% of the fuel, it is inappropriate to attribute 100% of the logistics tail cost to one system when calculating FBCE.

DoD Component organizations with responsibilities for scenario-based force planning, campaign model development, and force structure analysis should collaborate with responsible acquisition organizations to agree on a manageable subset of operational scenarios from the AoA that best represent the missions or duty cycles the system is being built to support. In the process of selecting scenarios, the force structure will determine the proper level of apportionment. Component organizations are encouraged to prepare fuel logistics and logistics force protection baselines for each common scenario to provide a starting point for AoAs and other acquisition trades that follow. As more acquisition programs perform these analyses and expertise builds, refinements to guidance and oversight criteria will be developed.

Figure 3.1.6.F1. FBCE Scenario Fuel Delivery Process Diagram



Assured Delivery Price Computation

The first item needed to compute the FBCE is the Assured Delivery Price (ADP). The price elements described in Figure 3.6.1.F2 (below) provide a framework for determining the ADP of fuel within a given scenario. It is a measure of the burdened cost of the fuel in $/gallon or $/barrel and all the tactical delivery assets and force protection needed to assure the fuel is safely delivered out to a given location. The ADP is the same for all users of fuel in that location using a given source of fuel and delivery method.

Price Elements to Determine Assured Delivery Price

Figure 3.6.1.F2. Summary of Price Elements to Apply within Each Scenario to Determine the Assured Delivery Price

Element #	Price Element	Burden Description
1	Fuel	Most recent DLA Energy "standard price" plus OMB-direct price inflation to the fiscal year of the scenario. In some cases, one may substitute a location-specific contract delivery price.

Element #	Price Element	Burden Description
2	Tactical Delivery Assets*	Includes all of the following:
	Fuel Delivery O&S Price	Per gallon price of operating service-owned fuel delivery assets including the cost of military and civilian personnel dedicated to the fuel mission.
	Depreciation Price of Fuel Delivery Assets	Captures the decline in value of fuel delivery assets with using straight-line depreciation over total service life. Combat losses due to attack or other loss (terrain, accident, etc.) should be captured as a fully depreciated vehicle.
	Infrastructure, environmental, and other miscellaneous costs over/above and distinct from the DLA Energy capitalized cost of fuel	Per gallon price of fuel infrastructure, regulatory compliance, tactical terminal operations, and other expenses as appropriate.
3	Security*	Potential per gallon price associated with delivering fuel, such as convoy escort and force protection. Includes the manpower, O&S, asset depreciation costs, and losses associated with force protection.

*These prices vary by Service and delivery method (ground, sea, air).

Although this figure provides a framework for calculating ADP, the elements must be tailored to a selected supply chain, system or platform type, and larger force structure context. In all cases, the results are scenario or unit-type-specific, and are not applicable for all situations. Each of the elements is discussed further in the following sections.

Fuel

The first price element for consideration is the fuel itself. DLA Energy serves as DoDs single supply center for petroleum products worldwide and for coal, natural gas, and electricity services within the continental United States. DLA Energy not only procures the energy products but serves as DoDs Integrated Materiel Manager for all petroleum products. DLA Energy charges the Services for the fuel delivered through a reimbursable arrangement known as the Defense Working Capital Fund.

The Standard Price established by DLA Energy is the rate that is charged to military customers at the retail point of sale worldwide. To simplify cost planning and accounting, the Standard Price for a given fuel is the same globally and does not represent the full capitalized costs DLA Energy incurs to deliver the fuel out to the point of sale. For purposes of calculating ADP, the Standard Price shall be used, referencing the most recent price update from DLA Energy. The Standard Price should then be inflated, using the most recent Office of Management and Budget inflation factors for

fuel prices, to the year in which the AoA scenarios in the analysis are set (e.g. 2018 or some future year at or after Initial Operational Capability).

In certain circumstances, particularly for current-day, site-specific calculations, DoD Components may use the actual contracted delivery price if it is available instead of the Standard Price. DLA Energy maintains a database of capitalized costs to purchase and deliver fuel at various supply points around the world. Site-specific fuel prices may only be used to inform rapid fielding and related procurement choices, as they represent market pricing in a specific operational situation. It is DLA Energy's responsibility to provide this data to DoD Components if required for these analyses. Since the FBCE is used for business case analyses and not to inform programming and budgeting for operation of platforms, the Services should not be concerned that this capitalized cost does not match the Standard Price it will be charged during actual operation of the platform under consideration.

Tactical Delivery Assets

The second price element captures the burdens associated with the tactical delivery assets used by the Services to deliver fuel from the point of sale to the system that will consume it. It includes the Operating and Support (O&S) costs, the cost of depreciation of the actual delivery assets, and any significant infrastructure costs needed to operate these assets.

Once the Services take over possession of fuel from DLA Energy at the point of sale, they must employ Service-owned delivery assets. For the purposes of ADP estimates, fuel delivery assets means major items of fuel delivery equipment, such as Navy oilers (T-AOs), aerial refueling aircraft (KC aircraft) for fixed-wing and rotary-wing aircraft, and tanker trucks and trailers for ground vehicles. It also includes C-130s airdropping palletized fuel and rotary-wing aircraft carrying fuel by sling load for delivery.

The O&S cost for the fuel delivery assets is measured in $/gallon and consists of the costs of operations and maintenance (O&M) of the vehicles and equipment and the costs for military and civilian manpower dedicated to the fuel delivery mission divided by the gallons of fuel delivered. For fuel delivery systems that are major systems in their own right, such as oilers or aerial refueling aircraft, actual O&S cost history is collected and made available to registered users of the Air Forces and Navy's Visibility and Management of Operating and Support Cost data systems. For other classes of equipment, cost and manpower data is found in planning factors used to develop O&M budgets and tables of organization and equipment associated with fuel delivery units. If the planning scenarios/missions being used for this calculation requires another Services assets to delivering fuel in the battlespace, Services may need share data.

The cost of depreciation of the primary fuel delivery assets is also part of the second price element. Normally, depreciation is not used in DoD analyses, since most studies tend to deal with equipment recapitalization costs explicitly. However, in this case, depreciation provides a measure of the decline in capital value of the fuel delivery

assets over time from use. The standard method is to use straight line depreciation over the anticipated service life of the primary fuel delivery asset. For example, for an ADP calculation for an aerial system that requires air-to-air refueling as part of its mission profile/duty cycle, this step would require inclusion of a depreciation value for the systems air refueling tanker.

An additional part of the cost of depreciation is the potential loss of delivery assets due to hostile attack or other attrition. Based on the scenario chosen, there is a definable probability that the associated logistics platforms will be interdicted and destroyed. If destroyed, the entire remaining value of the platform is immediately amortized and this cost is added to this price element. Depending on the quantity of fuel being carried by the delivery asset, an adjustment to the amount of fuel obtained from the point of sale will be required to account for this potential loss, if appropriate. Many cost and attrition factors related to fuel resupply convoys are available through existing combat models and historical databases.

Finally, miscellaneous infrastructure costs may be added if they significantly add to the cost of supporting the delivery assets and if the scenarios in the AoA involve energy infrastructure. These items may include the price of O&S and recapitalization for the facilities (such as fueling facilities and fuel storage sites) and related ground system equipment (such as pumps, fuel storage bladders, hose lines, and other refueling equipment to include maintenance and parts for refueling vehicles and other related ground refueling equipment). The costs to deploy the delivery assets may also be included, if the assets need to be transported to the theater of interest. This applies only to infrastructure that is operated by the military Services in the theaters of interest, and does not apply to infrastructure that is operated by DLA Energy and incorporated into the DLA Energy capitalized cost of fuel.

For DoD infrastructure, data sources and associated cost factors are centrally managed by the Office of the Deputy Under Secretary of Defense (Installations and Environment) and available to authorized users. Data on all DoD world-wide facilities is stored in the DUSD(I&E) Facilities Assessment Database. A four digit number known as the Facility Analysis Code (FAC) classifies each facility. For example, there is a unique code for each facility category such as marine fueling facility, POL pipeline, pump station, or fuel storage facility. For each four digit code, the DoD Facilities Pricing Guide provides cost factors used in DoD facilities cost models. Cost factors are expressed as annual costs per unit of measure (e.g., square foot) and are provided for facilities sustainment, modernization, and operations.

Security

The third and final price element includes the costs of escort protection of the fuel supply chain in hostile environments. In the case of DoD force protection assets allocated to the fuel delivery forces, the O&S costs, direct fuel costs and the depreciation cost of those forces will also have to be estimated and included in the overall calculation. In essence, all of the costs considered in the second price element

should also be considered for security assets. This includes the possibility that some security assets will be destroyed due to hostile activity while protecting the fuel supply chain. In some high-risk scenarios, force protection costs may be the largest factor in the FBCE estimate.

Fully Burdened Cost of Energy Computation

To arrive at the FBCE, the ADP is multiplied by the apportioned amount of fuel demanded by the system of interest. The FBCE is computed for each scenario being considered. Programs then have the option of reporting out the FBCE for each of the scenario they've assessed separately, or to provide their mean or weighted average, depending on anticipated usage of the system. To arrive at a single FBCE for the program, average these estimates based upon the relative amount of time that the system is expected to operate in each of the chosen scenarios.

Other Considerations

The FBCE, which is based on a simplified activity based costing framework, is meant to provide the acquisition process with a realistic, financial proxy for the fuel burden our forces will incur in the future battlespace. It is not meant to capture the operational impacts and capability gained or lost by changes in the logistical burden or in the unrefueled range of the system due to fuel consumption. The DoD force planning process and the analyses conducted to inform requirement development, the Joint Capabilities Integration Development System (JCIDS) process, are evolving to consider these variables. Because acquisition is governed by "cost, schedule, and performance", the requirements developer and approving authority should consider those fuel-related variables as part of the performance tradespace relative to the capability gap they are trying to fill.

The use of FBCE estimates do not normally identify near-term savings that can be identified in a budget. Choices made during an acquisition program to reduce the fuel demand will not begin to show an effect until after the system is fielded. Further, actual usage may vary considerably from the planning scenarios used in the AoA. This is often 10 to 20 years following an initial ICD for a major program, well beyond the FYDP. Readers interested in this subject should periodically check this section of the Guidebook for future updates to this framework.

3.2. Affordability

3.2.1. Affordability in the Decision Support Systems

3.2.1.1. Affordability in the JCIDS

3.2.1.2. Affordability Defined

3.2. Affordability

Affordability Analysis is a Component leadership responsibility that should involve the Components programming, resource planning, requirements, intelligence, and acquisition communities. The Department has a long history of starting programs that proved to be unaffordable. The result of this practice has been costly program cancelations and dramatic reductions in inventory objectives. Thus, the purpose of Affordability Analysis is to avoid starting or continuing programs that cannot be produced and supported within reasonable expectations for future budgets. Affordability constraints for both procurement and sustainment are derived early in program planning processes. These constraints are used to ensure requirements prioritization and cost tradeoffs occur as early as possible in the programs life cycle. Implementation of this new affordability policy is in early stages, so revisions to this guidance are likely in the future as the specific products and processes are developed.

Program life-cycle affordability is a cornerstone of DoD acquisition planning as indicated in DoD Directive 5000.01, Affordability within the Future Years Defense Program (FYDP) is also part of the Milestone Decision Authority (MDA) certification and monitoring required by section 2366b of title 10, United States Code, for Major Defense Acquisition Programs (MDAPs) at and beyond Milestone B (MS B). However, the intent of Affordability policy is to require additional affordability analysis that addresses the total life cycle of the planned program beyond the FYDP. Assessing life-cycle affordability of new and upgraded systems is crucial for long-range investment planning beyond the FYDP, establishing fiscal feasibility of the program, informing Analyses of Alternatives (AoAs), guiding requirements and engineering tradeoffs, and setting realistic program baselines to control life-cycle costs and help instill a more cost-conscious culture in the Department. Affordability analysis and management necessitates effective and ongoing communication with the requirements community on the cost and risk implications of requirements.

Section 3.2.1 describes how affordability is considered during the identification of military capability needs, and at acquisition milestone reviews. Section 3.2.2 provides parameters and analytic approaches for preparing affordability analyses. Section 3.2.3 describes affordability implementation and enforcement and Section 3.2.4 explains the Department's full-funding policy.

3.2.1. Affordability in Decision Support Systems

The Milestone Decision Authority (MDA) considers affordability at all major decision points of an acquisition program. Consideration and subsequent enforcement of affordability constraints help to ensure sufficient resources will be available to support the procurement and operation and support (O&S) of the system throughout its life cycle. The MDA also examines the realism of projected funding over the programs life cycle, given likely DoD Component resource constraints.

Affordability analysis and constraints are not intended to produce rigid, long-term plans. Rather, they are tools to promote responsible and sustainable investment decisions by examining the likely long-range implications of today's requirements choices and investment decisions based on reasonable projections of future force structure equipment needs-before substantial resources are committed to a program.

3.2.1.1. Affordability in JCIDS

Even before a program is approved for formal initiation into the acquisition process, affordability plays a key role in identifying capability needs as part of the Joint Capabilities Integration and Development System (JCIDS), which balances cost versus performance in establishing requirements for new acquisitions.

After the Materiel Development Decision (MDD), an Analysis of Alternatives (AoA) is initiated to examine potential materiel solutions to satisfy a capability need documented in an approved Initial Capabilities Document (ICD). Integral components of the AoA are the cost analyses of each material alternative under consideration as well as cost-effectiveness comparisons of the alternatives.

Moreover, all elements of life-cycle cost (or total ownership cost, if applicable) are documented as part of the Capability Development Document and the Capability Production Document (section 16 in both documents). To ensure the program is affordable, cost constraints are established to drive early consideration of potential tradeoffs.

3.2.1.2. Affordability Defined

Affordability is the ability to allocate resources out of a future total budget projection to individual activities. It is determined by Component leadership given priorities, values, and total resource limitations against all competing fiscal demands on the Component. Affordability goals set early cost objectives and highlight the potential need for tradeoffs within a program, and affordability caps set the level beyond which actions must be taken, such as reducing costs.

Affordability analysis and constraints are not synonymous with cost estimation and approaches for reducing costs. Constraints are determined in a top-down manner by the resources a Component can allocate for a system given inventory objectives and all other fiscal demands on the Component. Constraints then provide a threshold for procurement and sustainment costs that cannot be exceeded by the Program Manager (PM) without advanced permission of the MDA and Component leadership. On the other hand, cost estimates are generated in a bottom-up manner and forecast whether the system can be acquired under those constraints and at what level of risk. Thus, constraints are not set based on cost estimates but rather on a different calculus of whether a Component can afford the estimated costs of a system. The difference between the affordability constraints and the cost estimates indicate the levels of risk at

the current requirements and quantity levels, and whether actions must be taken to prevent exceeding the constraints.

Cost control and cost reduction approaches are central to maximizing the buying power of the Department and should be considered in all phases and aspects of program management as ways to meet or beat affordability constraints. Reducing the cost of program management, RDT&E, procurement, or sustainment of a product that meets validated requirements is always of importance, independent of achieving affordability constraints; however, if those constraints cannot be met-even with aggressive cost control and reduction approaches-then technical requirements, schedule, and planned quantities are revisited, with support from the Components Configuration Steering Board, with any requirements trades proposed to the validation authority. If constraints still cannot be met and the Component cannot afford to raise the constraint level by lowering constraints elsewhere in their analysis and obtaining MDA approval, then the program may be cancelled.

3.2.2. Affordability Analysis

3.2.2.1. Analysis Parameters

3.2.2. Affordability Analysis

Affordability analysis is the cornerstone process for the Component leadership to set priorities and determine what it can afford for each acquisition. Each DoD Component develops life-cycle affordability constraints for its ACAT I and IA acquisition programs for procurement unit cost and sustainment costs by conducting portfolio affordability analyses that contain a product life-cycle funding projection and supporting analysis. The basic procurement unit cost calculation is the annual estimated procurement budget divided by the number of items that should be procured each year to sustain the desired inventory.

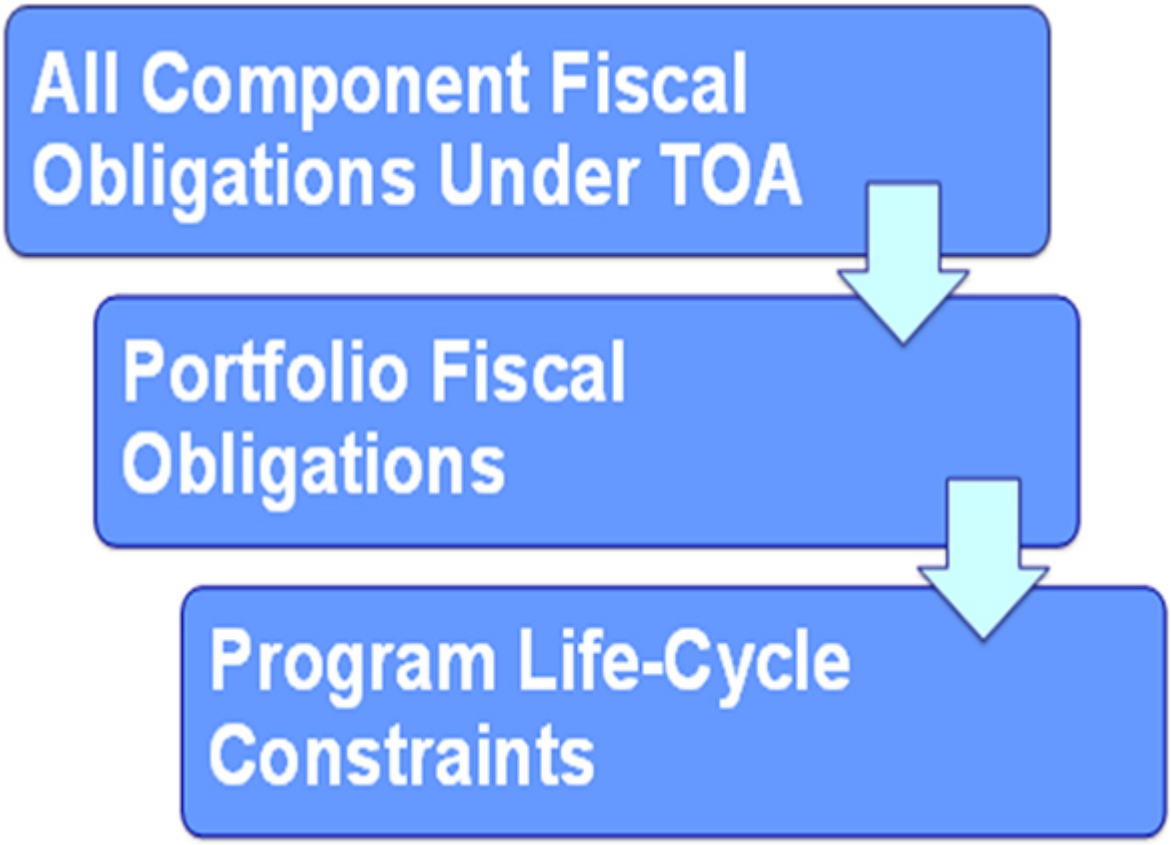
As a simple example, if $1 billion is projected to be available annually to sustain an inventory of 200,000 trucks, and the trucks have an expected service life of 20 years, then an average of 10,000 trucks must be procured each year, and the affordability constraint for procurement is $1 billion divided by 10,000, or $100,000 per truck.

Similar calculations are made to derive sustainment affordability constraints. Components standardize the portfolios they use for their analysis and can be based on mission areas or commodity types. These portfolios provide a collection of products that can be managed together for investment planning and oversight purposes. Components normally make trade-offs within portfolios, but if necessary, can and should make trade-offs across portfolios to provide adequate resources for high-priority programs.

3.2.2.1. Analysis Parameters

Component leadership-not the acquisition community or program management-conducts affordability analysis with support and inputs from their programming, resource planning, requirements, intelligence, and acquisition communities. Each Component determines the processes and analytic techniques they use for affordability analysis within the basic parameters described in the following paragraphs. As noted above, affordability analysis is a top-down process that starts with all fiscal demands on the Component. Figure 3.2.2.1.F1 summarizes the general approach from topline budget to portfolios to individual program constraints.

Figure 3.2.2.1.F1. Affordability Analysis Summary



A future total budget projection for each Component for affordability analysis provides the first-order economic reality and for allocation of estimated future resources to each portfolio. This projection establishes a nominal rather than optimistic foundation for the future and covers all fiscal demands that compete for resources in the Component, including those outside acquisition and sustainment.

The affordability analysis examines all programs and portfolios together, extending over enough years to reveal the life-cycle cost and inventory implications of the longest program for the Component. The same analysis is used as individual programs come

up for review. Nominally, affordability analysis covers at least 30 to 40 years into the future (especially for the Military Departments) but may be approximately 15 years for Components whose acquisitions all have planned life cycles of, and reach steady-state inventory in, 15 years or less (e.g., Components with only MAIS programs whose life cycles are estimated to be acquisition time plus 10 years after Full Deployment declaration).

The aggregation of portfolio cost estimates for each year, when combined with all other fiscal demands on the Component, may not exceed the Components reasonably anticipated future budget levels. Absent specific Component-level guidance by Director, Cost Assessment and Program Evaluation (DCAPE) or USD(AT&L), each Component projects its topline budget beyond the FYDP using the average of the last two years of the current FYDP and the OSD inflator provided by Under Secretary of Defense (Comptroller) (USD(C)), resulting in zero real growth.

3.2.2.2. Inputs and Structure

Portfolios. Components subdivide their accounts into portfolios to facilitate trade-off analysis; but when summed using the affordability constraints, the total cost for all portfolios and their elements cannot be above the Components future total budget projection. Components may use existing affordability portfolios, which are stable between affordability analysis updates. When the analysis is presented for a specific programs review, the Component employs the relevant portfolio to facilitate understanding and discussion of life-cycle costs and inventories of related acquisition systems.

Other Portfolio Plans. The Components affordability analyses should be consistent with any relevant existing portfolio plans and strategies such as those required by statute, e.g., the 30-year plans required by section 231 of title 10, United States Code, for ships, and section 231a of title 10, United States Code, for aircraft.

3.2.2.3. Updates

Each Component maintains and updates its affordability analysis as needed at the Component or portfolio level to reflect significant changes such as large cost growths in portfolios and programs, changes in defense strategy, force structure changes, or major budgetary changes.

3.2.2.4. Presentation

Each Components affordability analysis is presented within the governance framework to the MDA in preparation for major acquisition decisions in a format that demonstrates the affordability of the program within the Component and portfolio context, to ensure that the resulting affordability constraints are understood and consistent with the future total budget projection.

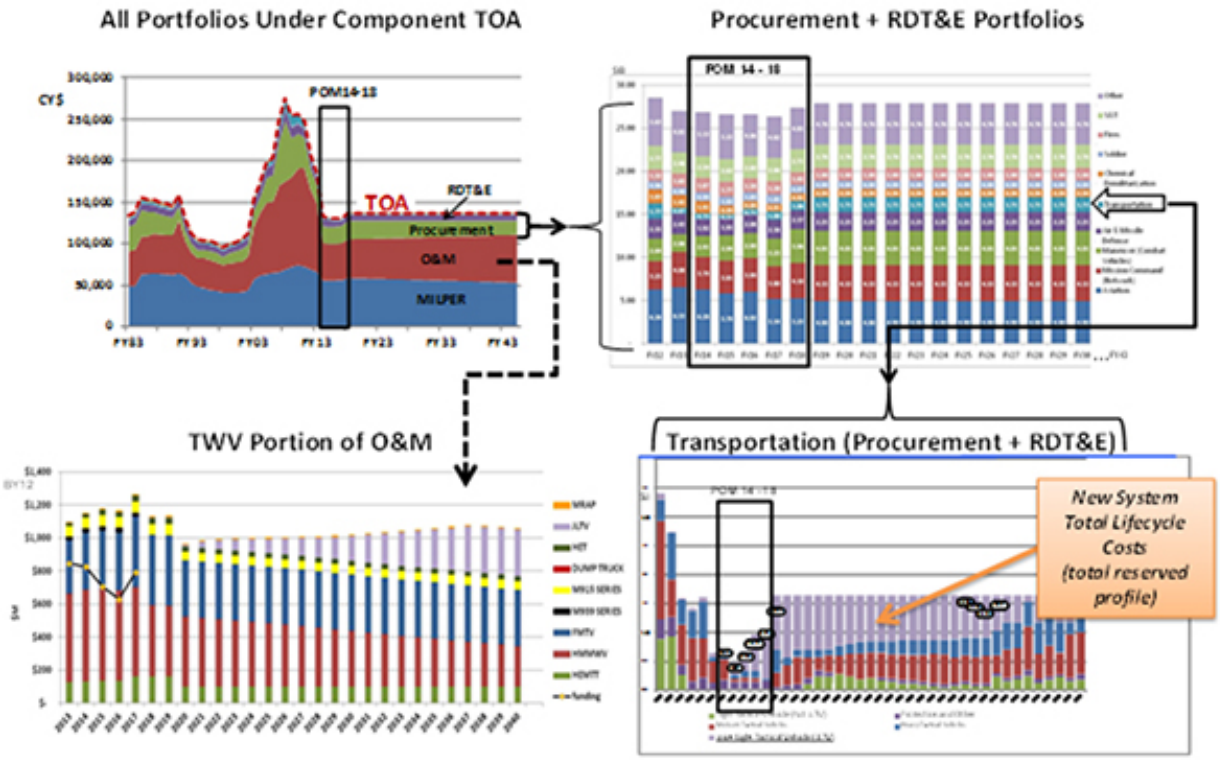
Transparency ensures that the risk, cost implications, and alternatives of system acquisitions and sustainment are sufficiently understood by the Component leadership and the programming, resource planning, requirements, intelligence, and acquisition communities.

3.2.2.5. Format

Each Component uses standardized templates provided by OUSD(AT&L) to present its affordability analysis. In general, standardized stacked area charts (or "sand charts") and spreadsheets listing the estimated budget by year for each element of the analysis, are adequate. The data should compare life-cycle estimates to the historical experience within the portfolio and the Component for sustainment and procurement costs.

At each major acquisition decision meeting, the Component provides stacked area charts ("sand charts") and underlying spreadsheet data showing the programs budget, what portfolio it fits within, and the top-level total of all portfolios and accounts totaling at or below the future total budget projection, equivalent to Total Obligation Authority (TOA), using the affordability constraints (refer to Figure 3.2.2.5.F1).

Figure 3.2.2.5.F1. Notional Example of Affordability Analysis Charts



An enlarged version of Figure 3.2.2.5.F1 is available for viewing by selecting/clicking on the image.

Notional examples used by the Army , Navy , and Air Force are provided for informational purposes.

3.2.2.6. Data Requirements

The affordability analysis must be consistent with the data in the Cost Analysis Requirements Description (CARD) for a program under review, including the requirements, quantity, and schedule used in the analysis. Affordability Analysis also provides data to support the procurement and sustainment constraints that are documented in the MDD, Milestone A, and Pre-B Acquisition Decision Memorandums (ADMs) and in the acquisition program baselines (APBs) normally set at Milestone B and beyond.

3.2.2.7. Timing

Affordability Analysis should be conducted as early as possible in a systems life cycle so that it can inform early requirements trades and the selection of alternatives to be considered during the AoA. Affordability constraints are not required before the MDD decision; however, conducting some analysis before that point is beneficial. The best opportunity for ensuring that a program will be affordable is through requirements tailoring that occur before and during the AoA(s) and early development. Thus, the Components incorporate estimated funding streams for future programs within their

affordability analyses at the earliest conceptual point and specify those estimates at MDD and beyond to inform system design concepts and alternative selection.

3.2.2.8. Incorporation in AoAs

Comprehensive and substantive examination of key requirements during AoAs is crucial for making programs more affordable. Thus, AoAs must seriously explore options below the affordability goal while making excursions above the goal to understand tradeoff options for Component leadership consideration.

3.2.3. Affordability Implementation and Enforcement

Affordability constraints are established to inform the requirements authority, PM, and AoA team of the cost limitations dictated by the Components affordability analysis.

3.2.3.1. Affordability Constraints Defined: Goals and Caps

Affordability goals are key objectives set to inform requirements and design tradeoffs during early research and development. Affordability caps are fixed requirements that are functionally equivalent to Key Performance Parameters (KPPs). Based on the Components affordability analysis and recommendations, the MDA sets and enforces affordability constraints as follows:

- **At MDD**: tentative affordability cost goals (e.g., total funding, annual funding profiles, unit procurement and/or sustainment costs, as appropriate) and inventory goals to help scope the AoA and provide targets around which to consider alternatives;
- **At Milestone A**: affordability goals for unit procurement and sustainment costs; and

- **At the Pre-B Decision Review, Milestone B, and Beyond**: binding affordability caps.

These constraints are documented in the ADMs for these decision points. At Milestone B, the affordability caps are documented in the programs APB. Any programs that skip earlier reviews, or have baselines set before Milestone B, receive goals or constraints commensurate with their position in the acquisition cycle and their levels of maturity.

3.2.3.2. Measuring Constraints

The type of measures used for MDA-approved affordability constraints on procurement and sustainment costs (e.g., Acquisition Program Unit Cost [APUC] or unit-recurring flyaway for procurement; and cost per operating hour and estimated reliability for sustainment) may be tailored to the type of acquisition and the specific circumstances of a given program. In addition to requirements tradeoffs approved by the requirements validation authority, prudent investments in RDT&E, innovative acquisition strategies, and incentives to reduce costs can be used to ensure that affordability constraints are achieved.

3.2.3.3. Monitoring and Reporting

The MDA enforces affordability constraints throughout the life cycle of the program. If a PM concludes that, despite efforts to control costs and reduce requirements an affordability constraint will be exceeded, then the PM notifies the Component Acquisition Executive and the MDA to request assistance and resolution. The PM also reports progress relative to affordability constraints at Defense Acquisition Executive Summary (DAES) reviews.

Inflators. When determining whether an affordability constraint has been exceeded in the life-cycle cost estimates, Components use the OSD inflator provided by USD(C) or, at the Components discretion, higher inflators reflecting historical experience.

3.2.3.4. Developing Proposed Constraints

As noted above, the affordability constraints are not based on cost estimates. Rather, the constraints are what the Component can afford to spend on the program under review relative to all other fiscal demands.

Once affordability is established, cost estimates can help inform the feasibility and risk of a set of proposed requirements given the affordable level of investment. Thus, at the point of establishing an APB, the affordability caps should be at least as high as the APB values (otherwise, the program will already require action to address cost and/or requirements). In practical terms, Components will likely want to propose caps above the APB values to allow for some flexibility in dealing with unforeseen issues. The amount by which the proposed caps exceed the APB values is at the Components discretion as long as the life-cycle cost at those caps, along with all other Component

fiscal demands, can be shown to fit within the Components future total budget projection.

The caps set the level at which the program may be de-scoped or cancelled, not what the cost estimates say a specified set of program requirements will cost.

3.2.3.5. Affordability for Lower ACAT Programs

Components are responsible for developing and issuing similar guidance to ensure life-cycle affordability for lower ACAT programs that have resource implications beyond the FYDP, and PMs should ensure they are familiar with that guidance.

3.2.4. Full Funding

It has been a long-standing DoD policy to seek full funding of acquisition programs, based on the most likely cost, in the budget year and out-year program years. DoD Directive 5000.01 affirms this full funding policy. Moreover, DoD Instruction 5000.02 requires full funding-defined as inclusion of the dollars and manpower needed for all current and future efforts to carry out the acquisition strategy in the budget and out-year program-as part of the entrance criteria for the transition into engineering and manufacturing development.

For MDAPs at MS B, the MDA must certify in writing to Congress that the program is fully funded through the period covered by the FYDP, relative to reasonable cost and schedule estimates that meet DCAPE concurrence. Other certification requirements are listed under section 2366b of title 10, United States Code. For all acquisition programs, the MDA normally assesses full funding at all major decision points. As part of this assessment, the MDA reviews the actual funding (in the most recent FYDP position) in comparison to the (time-phased) DoD Component Cost Estimate. In addition, the MDA considers the funding recommendations made by DCAPE (for Acquisition Category ID and IAM programs), or the DoD Component Cost Analysis team (for Acquisition Category IC and IAC programs). If the MDA concludes that the current funding does not support the acquisition program, then the ADMD may direct a funding adjustment and/or program restructure in the next FYDP update.

While full funding focuses on the FYDP, the long-range aspects of affordability analysis and constraints are meant to consider the implications beyond the FYDP of decisions made today.

3.3. Analysis of Alternatives

3.3.1. Introduction

3.3.2. Role of the AoA as Part of the Materiel Solution Analysis

3.3.2.1. Role of the AoA in Evolutionary Acquisition

3.3.1. Introduction

The Analysis of Alternatives (AoA) is an important element of the defense acquisition process. An AoA is an analytical comparison of the operational effectiveness, suitability, and life-cycle cost (or total ownership cost, if applicable) of alternatives that satisfy established capability needs. Initially, after the Materiel Development Decision, the AoA is initiated to examine potential materiel solutions with the goal of identifying the most promising option, thereby guiding the Materiel Solution Analysis phase (see section 3.3.2). Subsequently, an update to the AoA is initiated at the start of the Technology Development Phase and is reviewed at Milestone B (which usually represents the first major funding commitment to the acquisition program). The update to the AoA is used to refine the proposed materiel solution, as well as reaffirm the rationale, in terms of cost-effectiveness, for initiation of the program into the formal systems acquisition process. For Major Defense Acquisition Programs at Milestone A, the Milestone Decision Authority (MDA) must certify in writing to the Congress that the Department has completed an AoA consistent with study guidance developed by the Director, Cost Assessment and Program Evaluation (DCAPE), in addition to meeting other certification criteria (10 U.S.C. 2366a). For Major Defense Acquisition Programs at Milestone B, the

Milestone Decision Authority (MDA) must certify in writing to the Congress that the Department has completed an AoA with respect to the program in addition to meeting other certification criteria (10 U.S.C. 2366b). Pursuant to DoDI 5000.02, the AoA is updated as needed at Milestone C.

In practice, AoA issues vary somewhat between AoAs for weapon and other tactical systems and AoAs for major automated information systems. Sections 3.3.2 , 3.3.3 , and 3.3.4 provide discussion about AoAs that may be of general interest, although much of the discussion is focused on weapon systems. Section 3.3.5 discusses the AoA process for major automated information systems.

3.3.2. Role of the Analysis of Alternatives (AoA) as Part of the Materiel Solution Analysis

The analysis of alternatives process is expected to play a key role in support of the Materiel Solution Analysis Phase. After a program has an approved Materiel Development Decision, the analysis of alternatives process is expected to contribute to the selection of a preferred materiel solution that satisfies the capability need documented in the approved Initial Capabilities Document (ICD).

The Director, Cost Assessment and Program Evaluation (DCAPE), develops and approves study guidance for the AoA. The guidance is developed with the input of other DoD officials. Prior to the MDD review, DCAPE provides the AoA study guidance to the DoD Component designated by the MDA. Following receipt of the AoA study guidance, the DoD Component prepares an AoA study plan that describes the intended methodology for the management and execution of the AoA. The AoA study plan is coordinated with the MDA and approved by DCAPE prior to the MDD review. A suggested template for the AoA study plan is provided in section 3.3.3.

The study guidance shall require, at minimum, full consideration of possible trade-offs among cost, schedule, and performance objectives for each alternative considered. The study guidance shall also require an assessment of whether or not the joint military requirement can be met in a manner that is consistent with the cost and schedule objectives recommended by the JROC. The AoA study guidance and resulting AoA plan should build upon the prior analyses conducted as part of the Joint Capabilities Integration and Development System (JCIDS). The JCIDS process is briefly described in section 1.3, and is fully described in CJCS Instruction 3170.01. The JCIDS analysis process that leads to an approved Initial Capabilities Document (ICD) is built upon the analysis known as the Capabilities-Based Assessment (CBA). The CBA provides recommendations (documented in the ICD) to pursue a materiel solution to an identified capability gap that meets an established capability need. The CBA does not provide specific recommendations as to a particular materiel solution, but rather provides a more general recommendation as to the type of materiel solution (such as Information Technology system, incremental improvement to an existing capability, or an entirely new "breakout" or other transformational capability). In this way, the ICD can be used to establish boundary conditions for the scope of alternatives to be considered in the

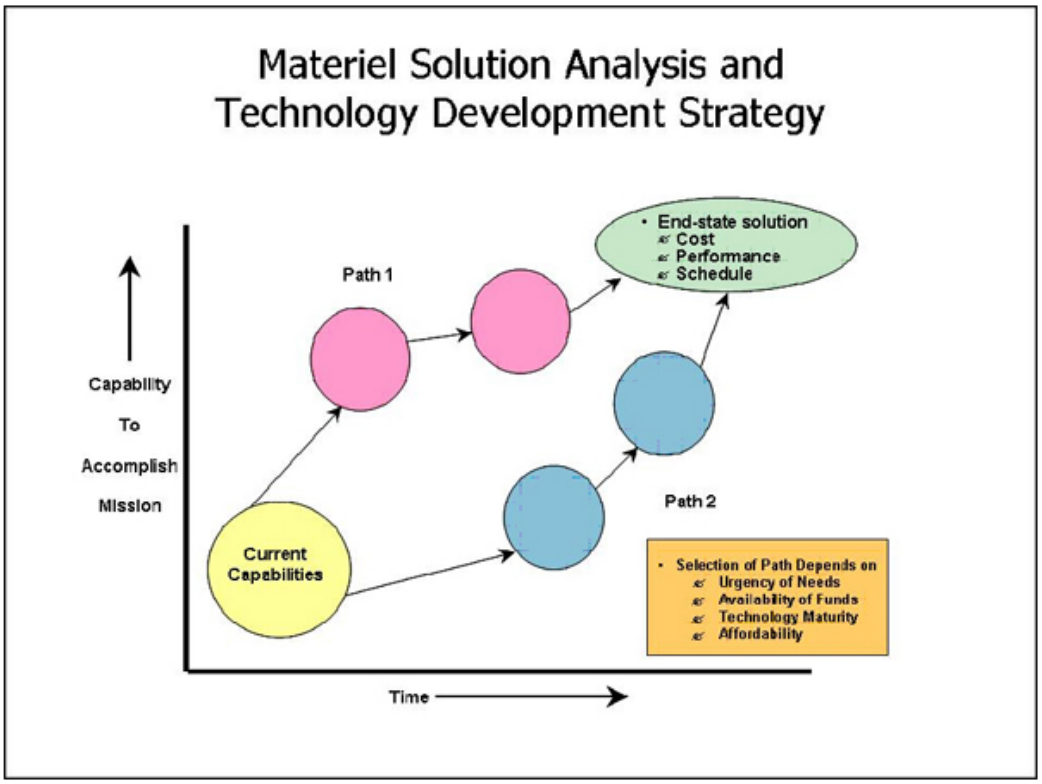
subsequent AoA. The AoA study guidance should be crafted to provide a fair balance between focusing the AoA and ensuring that the AoA considers a robust set of novel and imaginative alternatives.

The final AoA supporting a Milestone A decision is provided to the DCAPE not later than 60 days prior to the milestone decision review meeting. The evaluation criteria to be addressed in this assessment are provided in DoD Instruction 5000.02, Enclosure 7, paragraph 5, and are discussed further in section 3.3.4.1.

3.3.2.1. Role of the Analysis of Alternatives (AoA) in Evolutionary Acquisition

The AoA is used to identify the most promising end-state materiel solution, but the AoA also can play a supporting role in crafting a cost-effective and balanced evolutionary acquisition strategy. The alternatives considered in the AoA may include alternative evolutionary paths, each path consisting of intermediate nodes leading to the proposed end-state solution. In this way, the Materiel Solution Analysis can help determine the best path to the end-state solution, based on a balanced assessment of technology maturity and risk, and cost, performance, and schedule considerations (as shown in Figure 3.3.2.1.F1). The rationale for the proposed evolutionary acquisition strategy would be documented as part of the Technology Development Strategy.

Figure 3.3.2.1.F1. Establishment of an Evolutionary Acquisition Strategy



3.3.3. Analysis of Alternatives (AoA) Study Plan

The first major step leading to a successful AoA is the creation and coordination of a well-considered analysis plan. The study plan should establish a roadmap of how the analysis will proceed, and who is responsible for doing what. At minimum, the study plan should facilitate full consideration of possible trade-offs among cost, schedule, and performance objectives for each alternative considered, as well as an assessment of whether or not the joint military requirement can be met in a manner that is consistent with the cost and schedule objectives recommended by the JROC.

A recommended outline for the AoA plan would resemble the following:

- Introduction
  - Background
  - Purpose
  - Scope
- Ground Rules
  - Scenarios
  - Threats
  - Environment
  - Constraints and Assumptions
  - Timeframe
  - Excursions
- Alternatives
  - Description of Alternatives
  - Nonviable Alternatives
  - Operations Concepts
  - Sustainment Concepts
- Determination of Effectiveness Measures
  - Mission Tasks
  - Measures of Effectiveness
  - Measures of Performance
- Effectiveness Analysis
  - Effectiveness Methodology
  - Models, Simulations, and Data
  - Effectiveness Sensitivity Analysis
- Cost Analysis
  - Life-Cycle Cost Methodology
  - Additional Total Ownership Cost Considerations (if applicable)
  - Fully Burdened Cost of Delivered Energy (if applicable)
  - Models and Data
  - Cost Sensitivity and/or Risk Analysis
- Cost-Effectiveness Comparisons
  - Cost-Effectiveness Methodology
  - Displays or Presentation Formats
  - Criteria for Screening Alternatives
- Organization and Management
  - Study Team/Organization

- AoA Review Process
- Schedule

Of course, every AoA is unique, and the above outline may need to be tailored or streamlined to support a given situation. Each point in the above outline is discussed further in the next several sections.

3.3.3.1. Analysis of Alternatives (AoA) Study Plan-Introduction

The introduction to the AoA plan describes the developments that led to the AoA, including prior relevant analyses (such as the Capabilities-Based Assessment. It should reference the applicable capability needs document(s) and other pertinent documents, and highlight the capability gaps being addressed through the applicable capability needs. The introduction should describe the applicable AoA study guidance and any other terms of reference. It also should provide a broad overview of the planned AoA that describes in general terms the level of detail of the study, and the scope (breadth and depth) of the analysis necessary to support the specific milestone decision.

3.3.3.2. Analysis of Alternatives (AoA) Study Plan-Ground Rules

The ground rules described in the analysis plan include the scenarios and threats, as well as the assumed physical environment and any constraints or additional assumptions. The scenarios are typically derived from defense planning scenarios and associated joint operational plans, augmented by more detailed intelligence products such as target information and enemy and friendly orders of battle. Environmental factors that impact operations (e.g., climate, weather, or terrain) are important as well. In addition, environment, safety, and occupational health factors associated with the use of chemical and/or biological weapons may need to be considered as excursions to the baseline scenario(s).

The study plan should describe what future timeframe, or timeframes, will be considered in the analysis. Often, the time period(s) selected will be determined by the time period(s) assumed in the DoD-approved planning scenario. However, there is some flexibility on this point, especially if something significant-such as the deployment of a new capability, or the retirement of a legacy system-is projected to occur one or two years after one of the time periods in the scenario. A common and desirable practice is to consider two time periods of interest, say "near-term" and "far-term," separated by a decade or so.

The AoA study plan should describe the planned analytic excursions to the baseline scenarios and other major ground rules. Such excursions are strongly encouraged in order to explore any impact of changing threat levels, warning times, involvement of allied forces, political constraints on basing or overflights, just to name a few issues. These excursions can be used to see if there any major issues that are critical to the relative cost-effectiveness of the alternatives considered in the AoA.

3.3.3.3. Analysis of Alternatives (AoA) Study Plan-Range of Alternatives

The analysis plan also should document the range of alternatives to be addressed in the analysis. In many cases, there will be a minimum set of alternatives required by the initial analysis guidance. Additional direction during subsequent AoA reviews may insert yet other alternatives. Practically, the range of alternatives should be kept manageable. Selecting too few or too many are both possibilities, but experience has shown that selecting too many, exceeding the available resources of the AoA study team, is the greater concern. The number of alternatives can be controlled by avoiding similar but slightly different alternatives and by early elimination of alternatives (due to factors such as unacceptable life-cycle cost or inability to meet Key Performance Parameters). In many studies, the first alternative (base case) is to retain one or more existing systems, representing a benchmark of current capabilities. An additional alternative based on major upgrades and/or service-life extensions to existing systems also may be considered.

For each alternative, evaluating its effectiveness and estimating its life-cycle cost (or total ownership cost, if applicable) requires a significant level of understanding of its operations and support concepts. The operations concept describes the details of the peacetime, contingency, and wartime employment of the alternative within projected military units or organizations. It also may be necessary to describe the planned basing and deployment concepts (contingency and wartime) for each alternative. The sustainment concept for each alternative describes the plans and resources for system training, maintenance, and other logistics support.

It is important that the alternatives considered in the AoA should address alternative concepts for maintenance, training, supply chain management, and other major sustainment elements. In this way, the AoA can identify the preferred materiel solution not only in terms of traditional performance and design criteria (e.g., speed, range, lethality), but also in terms of support strategy and sustainment performance as well. In other words, the AoA should describe and include the results of the supportability analyses and trade-offs conducted to determine the most cost-effective support concept as part of the proposed system concept.

3.3.3.4. Analysis of Alternatives (AoA) Study Plan-Effectiveness Measures

The analysis plan should describe how the AoA will establish metrics associated with the military worth of each alternative. Military worth often is portrayed in AoAs as a hierarchy of mission tasks, measures of effectiveness, and measures of performance. Military worth is fundamentally the ability to perform mission tasks, which are derived from the identified capability needs. Mission tasks are usually expressed in terms of general tasks to be performed to correct the gaps in needed capabilities (e.g., hold targets at risk, or communicate in a jamming environment). Mission tasks should not be stated in solution-specific language. Measures of effectiveness are more refined and they provide the details that allow the proficiency of each alternative in performing the mission tasks to be quantified. Each mission task should have at least one measure of

effectiveness supporting it, and each measure of effectiveness should support at least one mission task. A measure of performance typically is a quantitative measure of a system characteristic (e.g., range, weapon load-out, logistics footprint, etc.) chosen to enable calculation of one or more measures of effectiveness. Measures of performance are often linked to Key Performance Parameters or other parameters contained in the approved capability needs document(s). Also, measures of performance are usually the measures most directly related to test and evaluation criteria.

3.3.3.5. Analysis of Alternatives (AoA) Study Plan-Effectiveness Analysis

The analysis plan spells out the analytic approach to the effectiveness analysis, which is built upon the hierarchy of military worth, the assumed scenarios and threats, and the nature of the selected alternatives. The analytic approach describes the level of detail at various points of the effectiveness analysis. In many AoAs involving combat operations, the levels of effectiveness analysis can be characterized by the numbers and types of alternative and threat elements being modeled. A typical classification would consist of four levels: (1) system performance, based on analyses of individual components of each alternative or threat system, (2) engagement, based on analyses of the interaction of a single alternative and a single threat system, and possibly the interactions of a few alternative systems with a few threat systems, (3) mission, based on assessments of how well alternative systems perform military missions in the context of many-on-many engagements, and (4) campaign, based on how well alternative systems contribute to the overall military campaign, often in a joint context. For AoAs involving combat support operations, the characterization would need to be modified to the nature of the support. Nevertheless, most AoAs involve analyses at different levels of detail, where the outputs of the more specialized analysis are used as inputs to more aggregate analyses. At each level, establishing the effectiveness methodology often involves the identification of suitable models (simulation or otherwise), other analytic techniques, and data. This identification primarily should be based on the earlier selection of measures of effectiveness. The modeling effort should be focused on the computation of the specific measures of effectiveness established for the purpose of the particular study. Models are seldom good or bad per se; rather, models are either suitable or not suitable for a particular purpose.

It also is important to address excursions and other sensitivity analyses in the overall effectiveness analysis. Typically, there are a few critical assumptions that often drive the results of the analysis, and it is important to understand and point out how variations in these assumptions affect the results. As one example, in many cases the assumed performance of a future system is based on engineering estimates that have not been tested or validated. In such cases, the effectiveness analysis should describe how sensitive the mission or campaign outcomes are to the assumed performance estimates.

3.3.3.6. Analysis of Alternatives (AoA) Study Plan-Cost Analysis

The AoA plan also describes the approach to the life-cycle cost (or total ownership cost (see section 3.1.5, if applicable) analysis. The cost analysis normally is performed in parallel with the operational effectiveness analysis. It is equal in importance as part of the overall AoA process. It estimates the total life-cycle cost (or total ownership cost) of each alternative, and its results are later combined with the operational effectiveness analysis to portray cost-effectiveness comparisons. What is important to emphasize is that the cost analysis will be a major effort that will demand the attention of experienced, professional cost analysts.

The principles of economic analysis apply to the cost analysis in an AoA. Although the cost estimates used in an AoA originally are estimated in constant dollars, they should be adjusted for discounting (time value of money), accounting for the distribution of the costs over the study time period of interest. In addition, the cost estimates should account for any residual values associated with capital assets that have remaining useful value at the end of the period of analysis. Further guidance on economic analysis is provided in DoD Instruction 7041.3, "Economic Analysis for Decisionmaking."

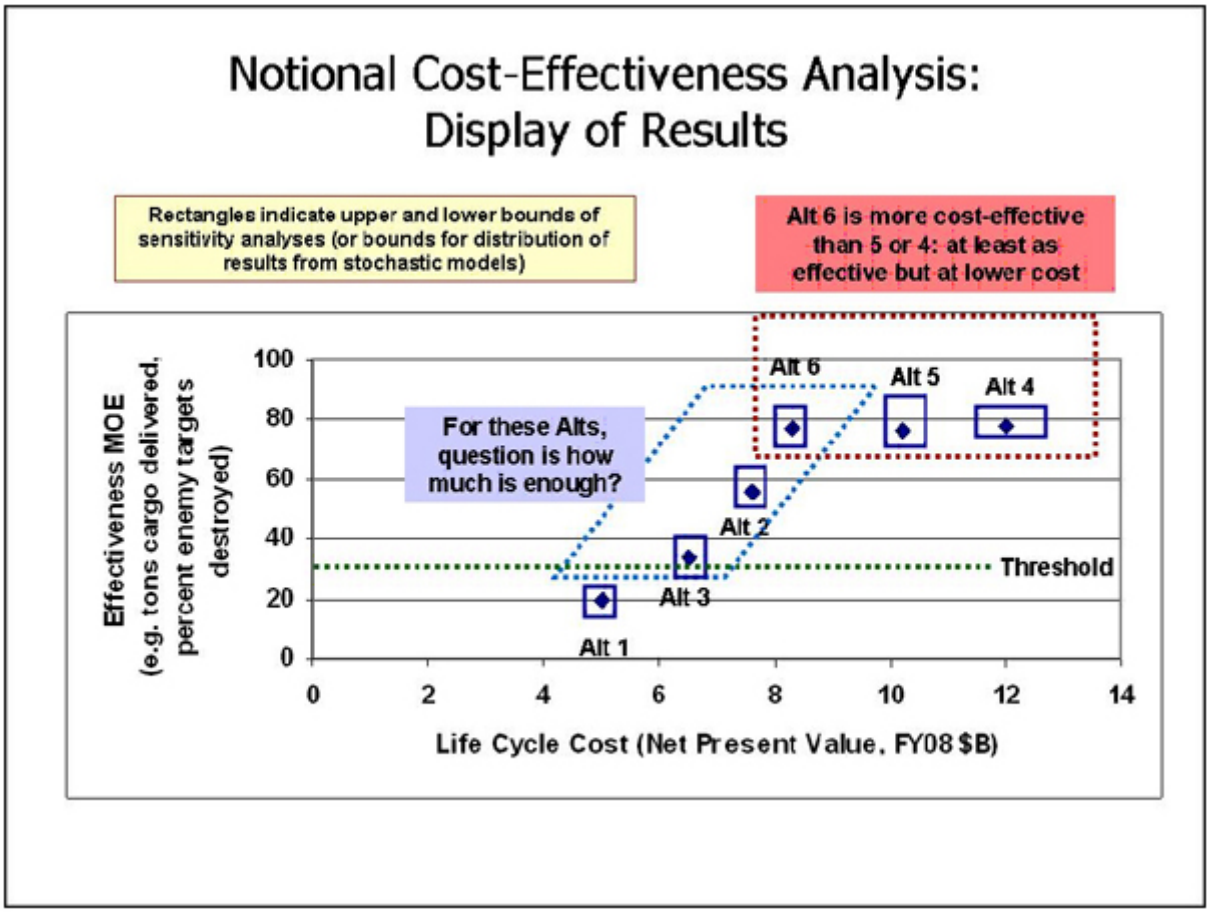
The cost analysis should also describe the planned approach for addressing the Fully Burdened Cost of Energy, for those AoAs where this issue is applicable. See section 3.3.4.1 for further information on this topic.

Further information on the recommended analytic approach for cost estimates is provided in section 3.7.

3.3.3.7. Analysis of Alternatives (AoA) Study Plan-Cost-Effectiveness Comparisons

Typically, the next analytical section of the AoA plan deals with the planned approach for the cost-effectiveness comparisons of the study alternatives. In most AoAs, these comparisons involve alternatives that have both different effectiveness and cost, which leads to the question of how to judge when additional effectiveness is worth additional cost. Cost-effectiveness comparisons in theory would be best if the analysis structured the alternatives so that all the alternatives have equal effectiveness (the best alternative is the one with lowest cost) or equal cost (the best alternative is the one with greatest effectiveness). Either case would be preferred; however, in actual practice, in many cases the ideal of equal effectiveness or equal cost alternatives is difficult or impossible to achieve due to the complexity of AoA issues. A common method for dealing with such situations is to provide a scatter plot of effectiveness versus cost. Figure 3.3.3.7.F1 presents a notional example of such a plot.

Figure 3.3.3.7.F1. Sample Scatter Plot of Effectiveness versus Cost



Note that the notional sample display shown in Figure 3.3.3.7.F1 does not make use of ratios (of effectiveness to cost) for comparing alternatives. Usually, ratios are regarded as potentially misleading because they mask important information. The advantage to the approach in the figure above is that it reduces the original set of alternatives to a small set of viable alternatives for decision makers to consider.

3.3.3.8. Analysis of Alternatives (AoA) Study Plan-Organization and Management

Finally, the AoA plan should address the AoA study organization and management. Often, the AoA is conducted by a working group (study team) led by a study director and staffed appropriately with a diverse mix of military, civilian, and contractor personnel. Program offices or similar organizations may provide assistance or data to the AoA study team, but (per DoD Instruction 5000.02, Enclosure 7) the responsibility for the AoA may not be assigned to a program manager, and the study team members should not reside in a program office. In some cases, the AoA may be assigned to an in-house analytic organization, a federally funded research and development center, or some other similar organization.

The AoA study team is usually organized along functional lines into panels, with a chair for each panel. Typical functional areas for the panels could be threats and scenarios,

technology and alternatives (responsible for defining the alternatives), operations and support concepts (for each alternative), effectiveness analysis, and cost analysis. In many cases, the effectiveness panel occupies the central position and integrates the work of the other panels. The study plan also should describe the planned oversight and review process for the AoA. It is important to obtain guidance and direction from senior reviewers with a variety of perspectives (operational, technical, and cost) throughout the entire AoA process.

The analysis plan is fundamentally important because it defines what will be accomplished, and how and when it will be accomplished. However, the plan should be treated as a living document, and updated as needed throughout the AoA to reflect new information and changing study direction. New directions are inevitably part of the AoA process, and so the analysis should be structured so as to be flexible. Frequently, AoAs turn out to be more difficult than originally envisioned, and the collaborative analytical process associated with AoAs is inherently slow. There are often delays in obtaining proper input data, and there may be disagreements between the study participants concerning ground rules or alternatives that lead to an increase in excursions or cases to be considered. Experience has shown that delays for analyses dealing with Special Access materials can be especially problematic, due to issues of clearances, access to data, storage, modeling, etc. It is often common for the study director to scale back the planned analysis (or at least consider doing so) to maintain the study schedule.

3.3.4. Analysis of Alternatives Final Results

3.3.4.1. Analysis of Alternatives (AoA) Final Results and Assessment

Normally, the final results of the AoA initially are presented as a series of briefings. For potential and designated major defense acquisition programs (Acquisition Category (ACAT) I) and major automated information systems (ACAT IA), the final AoA results are provided to the Office of the Director, Cost Assessment and Program Evaluation (CAPE), no later than 60 days prior to the milestone decision meeting (Defense Acquisition Board or Information Technology Acquisition Board review). Providing emerging results to CAPE prior to the final briefing is wise to ensure that there are no unexpected problems or issues. For other programs, the AoA results should be provided to the DoD Component entity equivalent to CAPE, if applicable. In any case, the AoA final results should follow all of the important aspects of the study plan, and support the AoA findings with the presentation. In particular, all of the stated AoA conclusions and findings should follow logically from the supporting analysis.

Having received the final AoA briefing(s), the CAPE evaluates the AoA and provides an independent assessment to the Head of the DoD Component (or the Principal Staff Assistant) and to the Milestone Decision Authority. DoD Instruction 5000.02, Enclosure 7, provides the evaluation criteria for this assessment. According to the Instruction, the CAPE, in collaboration with the OSD and Joint Staff, shall assess the extent to which the AoA:

1. Illuminated capability advantages and disadvantages;
2. Considered joint operational plans;
3. Examined sufficient feasible alternatives;
4. Discussed key assumptions and variables and sensitivity to changes in these;
5. Calculated costs; and,
6. Assessed the following:

- Technology risk and maturity;
- Alternative ways to improve the energy efficiency of DoD tactical systems with end items that create a demand for energy, consistent with mission requirements and cost effectiveness; and
- Appropriate system training to ensure that effective and efficient training is provided with the system.

The recommended template for the AoA study plan provided in Section 3.3.3 provides considerable guidance for conducting an AoA that would be responsive to the first five assessment criteria.

For the issue of technology risk and maturity, Section 3.3.2.1 provides a suggested approach where the AoA can help craft a cost-effective evolutionary acquisition strategy that is based on a balanced assessment of technology maturity and risk, as well as cost, performance, and schedule considerations.

For the issue of energy efficiency (applicable to tactical systems with end items that create a demand for delivered fuel or other forms of energy), Section 3.1.6 describes the analytic construct known as the Fully Burdened Cost of Delivered Energy; the Department now intends for this construct to play a major role in applicable AoAs.

For the issue of system training, the AoA should consider alternatives that provide for the individual, collective, and joint training for system operators, maintainers, and support personnel. The training system includes simulators and other training equipment, as well as supporting material such as computer-based interactive courseware or interactive electronic technical manuals. Where possible, the alternatives should consider options to exploit the use of new learning techniques, simulation technology, embedded training (i.e., training capabilities built into, strapped onto, or plugged into operational systems) and/or distributed learning to promote the goals of enhancing user capabilities, maintaining skill proficiencies, and reducing individual and collective training costs. Further information on system training is provided in Section 6.3.3. In addition to addressing the assessment criteria explicitly identified in DoD Instruction 5000.02, Enclosure 7, the AoA should also address alternative concepts for maintenance, supply chain management, and other sustainment elements (see Chapter 5 of this Guidebook).

3.3.4.2. Analysis of Alternatives (AoA) Final Report

Usually, in addition to a final briefing, the AoA process and results are documented in a written final report. The report typically is not published formally by the time of the program milestone decision review, due to schedule constraints. However, the report nevertheless may be important to the historical record of the program, since the report serves as the principal supporting documentation for the AoA. The report also may serve as a reference source for analysts conducting future AoAs. The final report can follow the same format as the study plan, with the addition of these sections:

- Effectiveness Analysis
  - Effectiveness Results
- Cost Analysis
  - Life-Cycle Cost (or Total Ownership Cost, if applicable) Results
- Cost-Effectiveness Comparisons
  - Cost-Effectiveness Results
  - Assessment of Preferred Alternative(s)

By following the same format, much of the material from the (updated) study plan can be used in the final report.

3.3.5. Analysis of Alternatives (AoA) Considerations for Major Automated Information Systems (MAIS)

DoD Instruction 5000.02, Enclosure 4, Table 2-1 and Table 3, requires an AoA for MAIS programs at milestone decisions. Much of the discussion on AoAs provided in the earlier sections of the Guidebook is more applicable to weapon systems, and needs to be modified somewhat for MAIS programs. This section discusses AoA issues for MAIS programs. The AoA should include a discussion of whether the proposed program (1) supports a core/priority mission or function performed by the DoD Component, (2) needs to be undertaken because no alternative private sector or governmental source can better support the function, and (3) supports improved work processes that have been simplified or otherwise redesigned to reduce costs, improve effectiveness, and make maximum use of commercial off-the-shelf technology. The analysis should be tied to benchmarking and business process reengineering studies (such as analyses of simplified or streamlined work processes, or outsourcing of non-core functions).

For all MAIS program AoAs, one alternative should be the status quo alternative as used in the Economic Analysis, and one alternative should be associated with the proposed MAIS program. Other possible alternatives could be different system, network, and/or data architectures, or they might involve different options for the purchase and integration of commercial-off-the-shelf products, modifications, and upgrades of existing assets, or major in-house development.

Most likely, the effectiveness analysis in a MAIS program AoA will not involve scenario-based analysis as is common for the weapon system AoAs. The effectiveness analysis for an MAIS program should be tied to the organizational missions, functions, and objectives that are directly supported by the implementation of the system being

considered. The results of the AoA should provide insight into how well the various alternatives support the business outcomes that have been identified as the business goals or capabilities sought. In some cases, it may be possible to express the assessment of effectiveness across the alternatives in monetary terms, and so effectiveness could be assessed as benefits in the framework for the Economic Analysis. In other cases, the effectiveness might be related to measurable improvements to business capabilities or better or timelier management information (leading to improved decision-making, where it can be difficult or impossible to quantify the benefits). In these cases, a common approach is to portray effectiveness by the use of one or more surrogate metrics. Examples of such metrics might be report generation timeliness, customer satisfaction, or supplier responsiveness. In addition to management information, the effectiveness analysis also should consider information assurance and interoperability issues.

The cost analysis supporting the AoA should follow the framework of the Economic Analysis. The life-cycle cost estimates of the alternatives considered in the AoA should be consistent with and clearly linked to the alternatives addressed in the Economic Analysis. Both the effectiveness analysis and the cost analysis should address the risks and uncertainties for the alternatives, and present appropriate sensitivity analysis that describes how such uncertainties can influence the cost-effectiveness comparison of the alternatives.

The appropriate sponsor or domain owner should lead the development of the AoA for a MAIS program. Experience has shown that the MAIS programs for which the sponsor or domain owner engages with the Office of the Director, Cost Assessment and Program Evaluation (CAPE) early in the process are much more likely to be successful than those that select a preferred alternative before contacting CAPE or before completing the AoA.

The DoD Component performing the AoA should develop a study plan that addresses the AoA study guidance, as applicable. At a minimum, the study plan should address the following topics:

AoA Study Plan Outline

a. Introduction (Background, Purpose & Scope)
b. Ground Rules: Constraints and Assumptions
c. Description of Alternatives
d. Determination of Effectiveness Measures
    1. Measures of Effectiveness (MOEs) operationally relevant & measurable
    2. Measures of Performance technical characteristics required to satisfy MOEs and are measurable & employed as an operational test criteria
e. Effectiveness Analysis Methodology
f. Cost Analysis
g. Cost-Effectiveness Comparisons
h. Risk & Sensitivity Analysis

1. Mission
2. Technology
3. Programmatic, to include funding

i. Study Organization and Management
j. Schedule, with associated deliverables

3.4. Cost Estimation for Major Defense Acquisition Programs

3.4.1. Independent Cost Estimates

The Director, Cost Assessment and Program Evaluation (DCAPE), conducts independent cost estimates (ICEs) for Major Defense Acquisition Programs (MDAPs) and Major Automated Information Systems (MAIS) programs for which the Under Secretary of Defense for Acquisition, Technology, and Logistics (USD(AT&L)) is the Milestone Decision Authority. An ICE is required for MDAPs prior to certification at Milestone A, certification at Milestone B, before any decision to enter into low-rate initial production or full-rate production, and in advance of certification following critical cost growth. An ICE is required for MAIS programs that have experienced a critical change.

An ICE may be conducted by DCAPE for MDAPs and MAIS programs for which USD(AT&L) is the MDA at any time considered appropriate by DCAPE or upon the request of the USD(AT&L).

For ACAT ID programs, DCAPE conducts the ICE (as described in Section 3.4.3), and for ACAT IC programs, the appropriate Service Cost Center or Defense Agency equivalent conducts the ICE. The Service Cost Centers are in the financial management organizations of their respective military departments, and are outside of their department's acquisition chain-of-command.

DCAPE and the Secretary of the Military Department concerned are required by Congress to report certain elements of program cost risk for MDAP and MAIS programs. For such programs, DCAPE and the Secretary of the Military Department concerned (or the head of the Defense Agency concerned) must state the confidence level used in establishing a cost estimate, the rationale for selecting the confidence level, and ensure that the confidence level provides a high degree of confidence that the program can be completed without the need for significant adjustment to program budgets.

The confidence level disclosure shall be included in the ADM approving the APB; in any other cost estimates for MDAPs or MAIS programs prepared in association with the estimates prepared in accordance with Section 3.4.1, above; and for MDAPs, in the next Selected Acquisition Report prepared in accordance with 10 U.S.C. 2432, or for MAIS programs, in the next quarterly report prepared in accordance with 10 U.S.C. 2445c.

3.4.2. DoD Component Cost Estimates

DCAPE reviews all cost estimates and cost analyses conducted in conjunction with MDAPs and MAIS programs. In order to accomplish this, 10 U.S.C. 2334(b) requires that DCAPE promptly receive the results of all cost estimates and analyses conducted by military departments and Defense Agencies (together, "DoD Component Cost Estimates").

Each DoD Component establishes a DoD Component-level cost position for all MDAPs and MAIS programs at milestone reviews. To support the Department's full funding policy for acquisition programs (see section 3.2.3), as well as statutory certifications and regulatory requirements, the DoD Component is expected to fully fund the program to this cost position in the current President's Budget Future Years Defense Program (FYDP), or commit to full funding of the cost position in the next President's Budget FYDP, with identification of specific offsets to address any funding shortfalls that may exist in the current FYDP. In addition, the appropriate Deputy Assistant Secretary of the Military Department for Cost and Economics (or defense agency equivalent) signs for the DoD Component-level cost position, and the DoD Component Acquisition Executive and the Component Chief Financial Officer endorses and certifies that the FYDP fully funds the program consistent with the DoD Component-level cost position. This policy

was promulgated in the OSD Memorandum, "Required Signed and Documented Component-level Cost Position for Milestone Reviews," dated March 12, 2009.

3.4.3. Office of Cost Assessment

3.4.3.1. Cost Assessment Reviews (Pre-Milestone Decisions and Full-Rate Production)

3.4.3.1.1. Cost Assessment Review Events-180 Days before Overarching Integrated Product Team (OIPT) Meeting

3.4.3.1.2. Cost Assessment Review Events-45 Days before Overarching Integrated Product Team (OIPT) Meeting

3.4.3.1.3. Cost Assessment Review Events-21 Days before Overarching Integrated Product Team (OIPT) Meeting

3.4.3.1.4. Cost Assessment Review Events-10 Days before Overarching Integrated Product Team (OIPT) Meeting

3.4.3.1.5. Cost Assessment Review Events-3 Days before Overarching Integrated Product Team (OIPT) Meeting

The Office of Cost Assessment (CA), within the Office of Cost Assessment and Program Evaluation (CAPE), receives the results of and reviews all cost estimates and cost analyses and associated studies conducted by the DoD Components for major defense acquisition programs (MDAPs) and major automated information system (MAIS) programs and has timely access to any records and data in the Department.

During the CA review process, CA staff may engage in discussion with the DoD Components regarding any discrepancies related to the cost estimates and comment on deficiencies regarding the methodology or execution of cost estimates. Furthermore, the Director, CAPE, is authorized to concur with the choice of a cost estimate used to support the acquisition program baseline (APB).

Although CA will provide periodic reviews, certain reviews are regular and required. For programs subject to CAPE review (normally Acquisition Category ID) that are approaching Milestone decisions or the Full-Rate Production Decision Review, CA staff conducts a comprehensive review, establishes a formal position on a program's life-cycle cost, and advises the Milestone Decision Authority accordingly. The CA review consists of preparation of an independent life-cycle cost estimate as well as an assessment of the DoD Component Cost Estimate. This section provides a brief summary of the major events associated with the CA review and provides additional information on the procedures for each event. A more comprehensive description of the

Cost Assessment review process is found in DoD 5000.04-M, "DoD Cost Analysis Guidance and Procedures," Section 2.

Table 3.4.3.1.T1 provides a brief summary of the major events and timelines associated with a Cost Assessment review leading to a Defense Acquisition Board milestone decision review:

Table 3.4.3.1.T1. Cost Assessment Timeline Associated with a DAB Milestone Decision Review

Event	Date
• Cost Assessment Review Kick-off Meeting o Draft Cost Analysis Requirements Description (CARD) Delivered by DoD Component	180 days before Overarching Integrated Product Team (OIPT) meeting
• Cost Assessment Briefs Preliminary Independent Life-Cycle Cost Estimate (LCCE) to Program Manager (PM) o Draft Documentation of DoD Component Cost Estimate Delivered by DoD Component o Final CARD Delivered by DoD Component	45 days before OIPT meeting
• Cost Assessment Review Meeting o PM Representative Briefs Program Defined in CARD, and Program Office Cost Estimate o DoD Component Representative Briefs Component Cost Position, if applicable o Cost Assessment Briefs Final Estimate of Independent LCCE to PM	21 days before OIPT meeting
• Final Documentation of DoD Component Cost Estimate Delivered by DoD Component	10 days before OIPT meeting
• OSD Cost Assessment Report Delivered to OIPT Members	3 days before OIPT meeting

3.4.3.1.1. Cost Assessment Review Events-180 Days before Overarching Integrated Product Team (OIPT) Meeting

The Cost Assessment (CA) review process begins roughly six months before the planned Defense Acquisition Board milestone review. At that time, the draft Cost Analysis Requirements Description (CARD) is provided to CA for review. The CARD is used to describe formally the acquisition program for purposes of preparing both the DoD Component Cost Estimate and the CA independent cost estimate. CA staff promptly evaluates the CARD for completeness and consistency with other program documents (such as capability needs documents, acquisition strategy, etc.). As part of this evaluation, CA staff may require access to privileged information such as contractor proposals that are proprietary or source selection sensitive. CA staff will follow all necessary procedures to ensure that the integrity of the privileged information is protected.

The expectation is that the CARD should be sufficiently comprehensive in program definition to support a life-cycle cost estimate. Normally, CA staff provides any necessary feedback to the DoD Component if any additional information or revisions are needed. If the CARD is found to be deficient to the point of unacceptability, the Deputy Director, CA, will advise the OIPT leader that the planned milestone review should be postponed.

At roughly the same time that the draft CARD is submitted, CA staff announces its upcoming review in a formal memo. The memo initiates a working-level kick-off meeting that is held with representatives from the program office cost estimating team, the CA independent cost estimate team, and other interested parties (typically DoD Component or OSD staff members). The purpose of the meeting is to discuss requirements and issues for the upcoming milestone review, the scope of the cost estimates, and ground rules and assumptions on which the estimates will be based. Much of the discussion will focus on material provided in the draft CARD. This ensures that both cost teams have a common understanding of the program to be costed. In addition, ground rules are established for CA interactions with the program office. CA staff also coordinates any travel or visit requirements with appropriate DoD Component points of contact.

3.4.3.1.2. Cost Assessment Review Events-45 Days before Overarching Integrated Product Team (OIPT) Meeting

Per DoD Instruction 5000.02, Enclosure 7, section 4, Cost Assessment (CA) staff will brief the preliminary independent Life-Cycle Cost Estimate (LCCE) to the program manager (PM) 45 days before the OIPT meeting. In a similar timeframe, the program office should provide draft documentation of its estimate to the CA staff, and if applicable, the DoD Component should provide draft documentation of the DoD Component Cost Position. The CA report eventually submitted to the OIPT and to the Defense Acquisition Board membership provides not only the CA independent cost estimate but also an evaluation of the DoD Component Cost Estimate. It is therefore important for the DoD Components to submit well-documented cost estimates that are ready for review.

The specific standards for the cost documentation are described in DoD 5000.04-M, "DoD Cost Analysis Guidance and Procedures," Sections 1 and 2. In general, the documentation should be sufficiently complete and well organized that a cost professional could replicate the estimate, given the documentation. Along with the draft documentation of the program office cost estimate, the DoD Component provides an updated (and final) Cost Analysis Requirements Description to CA staff. At the same time that the documents are provided, CA staff will provide feedback and identify any emerging cost issues to the program manager and DoD Component staff, in part based on CA work to date on its independent cost estimate.

3.4.3.1.3. Cost Assessment Review Events-21 Days before Overarching Integrated Product Team (OIPT) Meeting

Per DoD Instruction 5000.02, Enclosure 7, section 4, CA staff will brief the results of the independent cost estimate to the program manager 21 days before the OIPT meeting. This is normally handled as part of the CA review meeting. At this time, the program office should provide their final estimate to the Cost Assessment staff, and the DoD Component should provide the final DoD Component Cost Position. Other invited OSD and Joint Staff representatives may attend these reviews/exchanges. A typical presentation format for the Cost Assessment review meeting would include:

- Program overview and status
- Program office acquisition cost estimate
  - Summary of results
  - Methodology for high-cost elements
- Rationale for DoD Component cost position, if applicable
- Comparison of (time-phased) program office cost estimate to current funding
- Operating and Support cost estimate

In addition, at the CA meeting, CA staff provides any further feedback to the program office and DoD Component staff. If appropriate, CA staff will provide a presentation of the major areas of difference between its independent cost estimate and the program office cost estimate and/or DoD Component cost position.

3.4.3.1.4. Cost Assessment Review Events-10 Days before Overarching Integrated Product Team (OIPT) Meeting

At least 10 days before the OIPT meeting, the DoD Component provides final documentation if its cost estimate (program office cost estimate, or DoD Component Cost Position where applicable).

3.4.3.1.5. Cost Assessment Review Events-3 Days before Overarching Integrated Product Team (OIPT) Meeting

Cost Assessment (CA) staff's final report is delivered to the OIPT leader at least three days before the OIPT meeting. Immediately thereafter, it is distributed to the OIPT

members and is available to the DoD Component staff. The expectation is that any issues had already emerged in prior discussions and that the final CA report should not contain any surprises. The report normally is two to three pages and typically includes the following:

- Summary of DoD Component Cost Estimate
- Summary of Cost Assessment independent cost estimate
- Comparison or reconciliation of the two estimates
- Assessment of program risks
- Comparison of (time-phased) Cost Assessment cost estimate to current program funding
    - Recommendations concerning program funding

3.4.3.2. Cost Estimates for Milestone A Reviews

Per DoD Instruction 5000.02, Enclosure 2, section 5.c.(5), the DoD Component at Milestone A submits a cost estimate for the proposed materiel solution(s). Also, per 10 U.S.C. 2334, the Director of Cost Assessment and Program Evaluation (DCAPE) conducts an independent cost estimate in advance of Milestone A certification. In order to facilitate these estimates, the cost estimating procedures at Milestone A will track those at the other milestone decisions points. This includes the required preparation of a Cost Analysis Requirements Description (CARD), see below, although the early stage of the program development will necessitate less specificity in many of the required elements within the CARD.

The actual process and timing leading to the DoD Component estimate may vary among programs, and therefore, a tailored approach should be developed and proposed. Early in the Materiel Solution Analysis Phase, the Program Manager and DoD Component staff should work with the OSD Office of Cost Assessment (CA) and Acquisition Resources & Analysis staffs to develop a plan and schedule for delivery of the cost estimate to support the upcoming Milestone A review. The plan is subject to approval of the Milestone Decision Authority (MDA).

The DoD Component Cost Estimate, in addition to the DCAPE independent cost estimate, is used to support the MDA certification requirements for Milestone A (10 U.S.C. 2366a). The emphasis for the Milestone A cost estimate is to provide costing adequate to support the selection of the preferred materiel solution(s) identified by the Analysis of Alternatives, and to support a determination by the MDA that current funding for the Technology Development Phase (required technology development, competitive prototyping, and possibly preliminary design of the end-item system) is adequate. The Milestone A cost estimate is a complete estimate of the system life-cycle cost. However, for the costs associated with the acquisition phases beyond Technology Development (i.e., Engineering and Manufacturing Development, Production and Deployment, and Operations and Support), the Milestone A cost estimate typically would not have the same level of rigor or fidelity as will later cost estimates (prepared for milestones B and beyond). Although the cost estimate addresses the complete life-cycle cost, since it

must support the Analysis of Alternatives process, only the program development and procurement costs are subject to certification.

The DoD Component Cost Estimate submitted at Milestone A should be based on a sound description of the program and follow the general requirements of the CARD. Understandably, programs at Milestone A are less well-defined than programs at later milestone decision points. The Initial Capabilities Document, Technology Development Strategy, Systems Engineering Plan, Test and Evaluation Strategy, and Analysis of Alternatives, together with the CARD, should be used to provide a technical and programmatic description that should be the foundation for the cost estimate.

Note that if the certified cost estimate grows at least 25 percent during the Technology Development Phase, then the Program Manager must notify the MDA of the increase. The MDA in turn consults with the Joint Requirements Oversight Council to reassess program requirements and the military need(s) for the system. See DoD Instruction 5000.02, Enclosure 2, section 5.c.(3) for further guidance.

3.4.4. Cost Assessment Reporting Requirements

3.4.4.1. Cost Analysis Requirements Description (CARD)

A sound cost estimate is based on a well-defined program. For Acquisition Category (ACAT) I and ACAT IA programs, the CARD is used to formally describe the acquisition program for purposes of preparing both the DoD Component Cost Estimate and the Cost Assessment independent cost estimate. DoD Instruction 5000.02 specifies that for major defense acquisition programs, the CARD will be provided in support of major milestone decision points (Milestone B, Milestone C, or the full-rate production decision review). In addition, for Major Automated Information Systems, the CARD is prepared whenever an Economic Analysis is required. For other acquisition programs, the preparation of a CARD, or an abbreviated CARD-like document with appropriate tailoring, is strongly encouraged to provide a written program description suitable to support a credible life-cycle cost estimate.

The CARD is prepared by the program office and approved by the DoD Component Program Executive Officer. For joint programs, the CARD includes the common program agreed to by all participating DoD Components as well as all unique program requirements of the participating DoD Components. DoD 5000.4-M, "DoD Cost Analysis Guidance and Procedures," Chapter 1, provides further guidelines for CARD content.

3.4.4.1.1. Cost Analysis Requirements Description (CARD) Outline

- System description and characteristics
    - System overview
    - System performance parameters and characteristics
    - Technical and physical description
    - Work breakdown structure
    - Summary of maturity levels of critical technologies
    - Software description and sizing information
    - Interfaces with other systems
    - Subsystem descriptions, as appropriate
- System suitability factors
    - Reliability/Maintainability/Availability
- Predecessor and/or Reference System
- PM's assessment of program risk and risk mitigation measures
- System operational concept
    - Organizational/unit structure
    - Basing and deployment description (peacetime, contingency, and wartime)
    - System sustainment concept
    - System logistics concept
        - Maintenance concept
        - Supply management concept
        - Transportation concept
    - Software maintenance concept
    - System training concept
- Time-phased system quantity requirements
- System manpower requirements
- System activity rates (operating tempo or similar information)
- Facilities requirements
- Summary of security or program protection features
- Summary of environment, safety, and occupational health considerations
- System milestone schedule
- Summary of acquisition plan or strategy
- Plans for system disposal
- Track to prior CARD
- Approved or proposed CSDR plan

3.4.4.1.2. Cost Analysis Requirements Description (CARD) Content

For each topic listed in the suggested outline, the CARD should provide information and data for the program to be costed. In addition, the CARD should include quantitative comparisons between the proposed system and a predecessor and/or reference system for the major topics, as much as possible. A reference system is a currently operational or pre-existing system with a mission similar to that of the proposed system. It is often the system being replaced or augmented by the new acquisition. For a program that is a major upgrade to an existing weapon platform, such as an avionics replacement for an operational aircraft, the new system would be the platform as equipped with the upgrade, and the reference system would be the platform as equipped prior to the upgrade. For Major Automated Information System programs, the CARD format described above may need to be tailored.

The level of detail provided in the CARD will depend on the maturity of the program. Programs at the Pre-Engineering and Manufacturing Development Review are less well-defined than programs at Milestone C or at full-rate production. In cases where there are gaps or uncertainties in the various program descriptions, these uncertainties should be acknowledged as such in the CARD. This applies to uncertainties in either general program concepts or specific program data. For uncertainties in program concepts, nominal assumptions should be specified for cost-estimating purposes. For example, if the future depot maintenance concept were not yet determined, it would be necessary for the CARD to provide nominal (but specific) assumptions about the maintenance concept. For uncertainties in numerical data, ranges that bound the likely values (such as low, most likely and high estimates) should be included. In general, values that are "to be determined" are not adequate for cost estimating. Dealing with program uncertainty in the CARD greatly facilitates subsequent sensitivity or quantitative risk analyses in the life-cycle cost estimate.

For programs employing an evolutionary acquisition strategy, the CARD should be structured to reflect the specifics of the approach. Although the circumstances may vary somewhat by program, normally the CARD should attempt to include as much of the program, including known future increments, as can be described at the time of the milestone decision review, and clearly document any exclusions for portions of the program that cannot be defined at the present time.

The last section of the CARD should contain a copy of the approved Cost and Software Data Reporting plan (see section 3.4.4.2), if available. If the plan has not yet been approved, then the proposed plan should be included as part of the CARD.

3.4.4.1.3. Cost Analysis Requirements Description (CARD) and Other Program Documentation

Clearly, much of the information needed for the CARD is often available in other program documents. The CARD should stand-alone as a readable document but can make liberal use of appropriate references to the source documents to minimize redundancy and effort. In such cases, the CARD should briefly summarize the information pertinent to cost in the appropriate section of the CARD and provide a

reference to the source document. DoD Instruction 5000.02, Enclosure 7, paragraph 2, states that the program manager shall synchronize preparation of the CARD with other program documentation so that the final CARD is consistent with other final program documentation. The source documents should be readily available to the program office and independent cost estimating teams or can be provided as an appendix to the CARD. Many program offices provide controlled access to source documents through a web site (perhaps at a ".mil" web address or on the Secret Internet Protocol Router Network).

Common source documents for the CARD include:

- Technology Readiness Assessment (TRA);
- Capability Needs Documents (i.e., Initial Capabilities Document / Capability Development Document /Capability Production Document);
- Acquisition Strategy;
- Life-cycle Sustainment Plan (part of the Acquisition Strategy);
- Test and Evaluation Master Plan;
- Manpower Estimate; and
- Systems Engineering Plan.

The CARD should be consistent with any contractual solicitations, such as a Request for Proposal or any accompanying document (e.g., System Requirements Document).

3.4.4.1.4. Cost Analysis Requirements Description (CARD) at Milestone B

For programs at the Pre-Engineering and Manufacturing Development (EMD) Review, the program content described in the final CARD should reflect the program definition established during the Technology Development Phase. For all MDAPs, the Preliminary Design Review (PDR) may be conducted before the Pre-EMD Review and Milestone B approval, and the CARD should also incorporate the results from the PDR for such cases.

Another issue for the CARD at the Pre-EMD Review can occur when the Technology Development Phase maintains two or more competing contractor teams (that are producing prototypes of the system) up to and through the PDR. In this situation, there are two possible approaches for the preparation of the CARD. If the competing teams are using similar technologies and designs, then a single generic CARD, based on a nominal Government design, may be used to prepare a single ICE for the nominal design. If the competing teams have significantly different technologies or designs, then it may be necessary to prepare offeror-specific CARDs, which in turn may be used to prepare multiple ICEs. For programs with competing prototype teams approaching a Pre-EMD Review, the DoD Component should discuss its proposed use of a single generic CARD, or use of multiple offeror-specific CARDs, with the Cost Assessment staff at the Kick-Off Review meeting (see section 3.4.3.1.1), if not earlier.

3.4.4.2. Cost and Software Data Reporting (CSDR)

The CSDR system is the primary means that DoD uses to collect and program managers use to report actual cost, software, and related business data on Acquisition Category (ACAT) I, ACAT IA, pre-MDAP, pre-MAIS, and sustainment defense contracts. The repository of collected data serves as the primary contract cost and software data repository for most DoD resource analysis efforts, including cost database development, applied cost estimating, cost research, program reviews, analysis of alternatives, and life cycle cost estimates. The two principal components of CSDR are contractor cost data reporting (CCDR) and software resources data reporting (SRDR).

The Deputy Director, Cost Assessment establishes procedural guidance and reporting formats for the CSDR system and monitors implementation throughout the Department of Defense. DoD 5000.04-M-1, "Cost and Software Data Reporting (CSDR) Manual," establishes the policies and procedures for CSDR and provides report formats and definitions, specific report examples, and other related information. The CSDR Manual is available on the Defense Cost and Resource Center (DCARC) web site. Access to CSDR data is readily provided by DCARC to DoD government cost analysts and

sponsored support contractors possessing Non-Disclosure Agreements who are registered users.

3.4.4.2.1. Contractor Cost Data Reporting (CCDR)

The CCDR system collects data on the development, production, and sustainment costs incurred by contractors in performing DoD ACAT I, ACAT IA, pre-MDAP, pre-MAIS, and sustainment program contracts. DoD Instruction 5000.02, Enclosure 4, Table 4, establishes the CCDR requirements for Acquisition Category I and IA contracts and sub-contracts, regardless of contract type. Detailed procedures and other implementation guidance are found in DoD 5000.04-M-1, "Cost and Software Data Reporting (CSDR) Manual."

CCDR focuses on the collection of actual total contract costs that are subdivided into standard categories for cost estimating purposes by Work Breakdown Structure (WBS), functional categories, and resource elements. CCDR reports provide a display of incurred costs to date and estimated incurred costs at completion by elements of the WBS, with nonrecurring costs and recurring costs separately identified. In some cases, CCDR reports can display incurred costs to date and estimated incurred costs at completion by functional category (manufacturing labor, engineering, etc.). Where appropriate, a functional category is broken out by direct labor hours, direct material, overhead, and other indirect.

3.4.4.2.1.1. Contractor Cost Data Reporting (CCDR) Requirements

CCDR reports are required on all major contracts and subcontracts, regardless of contract type, for Acquisition Category I and IA programs and pre-Major Defense Acquisition Program and pre-Major Automated Information System programs subsequent to Milestone A approval, valued at more than $50 million Then year dollars. CCDRs are not required for contracts priced below $20 million Then year dollars. The CCDR requirement on high-risk or high-technical-interest contracts priced between $20 and $50 million is left to the discretion of the DoD Program Manager (PM) based upon the advice of the Cost Working-level Integrated Product Team (CWIPT). These requirements must also be approved by the Deputy Director, Cost Assessment. CCDRs are not required for procurement of commercial systems provided the DoD PM requests and obtains approval for a reporting waiver from the Deputy Director, Cost Assessment.

3.4.4.2.1.2. Contractor Cost Data Reporting (CCDR) Level of Reporting

CCDR shall normally be at level 3 (level 4 for space contracts) of the Contract Work Breakdown Structure (WBS) and determined separately for each prime contractor and subcontractor that meets the reporting thresholds. Reporting at levels 4 and below shall be required on prime contracts or subcontracts containing WBS elements that address high-risk, high-value, or high-technical-interest areas of a program. Such reporting applies only if the CWIPT proposes and the Deputy Director, Cost Assessment approves.

3.4.4.2.1.3. Contractor Cost Data Reporting (CCDR) Report Timing

Initial reports, if required, are due within 60 days following the completion of the integrated baseline review when a pre-award or post-award conference is held. If a conference is not held, the initial report, if required, is due within 180 days of contract award. For subsequent reporting on development contracts, reporting contractors typically shall submit CCDR reports after such major events as first flight or completion of prototype, before major milestones, and upon contract completion. Annual reporting is allowed if requested and approved by the Deputy Director, Cost Assessment. For production, reporting contractors normally shall submit CCDR reports upon the delivery of each annual lot for all weapon systems. Due to the extended construction process for ships, CCDR reports are also required for the total number of ships in each buy and for each individual ship within that buy at three intervals-initial report (total buy and individual ships), the mid-point of first ship construction (individual ships only) or other relevant timeframe as the CWIPT determines, and after final delivery (total buy and individual ships).

3.4.4.2.1.4. Contractor Cost Data Reporting (CCDR) Formats and Instructions

CCDR reports consist of the following forms:

- DD Form 1921, "Cost Data Summary Report"
- DD Form 1921-1, "Functional Cost-Hour Report"
- DD Form 1921-2, "Progress Curve Report"
- DD Form 1921-3, "Contractor Business Data Report"

The related instructions are included in the DIDs for these forms as follows:

- DD Form 1921: DID, DI-FNCL-81565
- DD Form 1921-1 DID, DI-FNCL-81566
- DD Form 1921-2 DID, DI-FNCL-81567
- DD Form 1921-3 DID, DI-FNCL-81765

The forms including the Microsoft Excel templates and the link to the official DIDs are shown on the DCARC web site. The DCARC also provides software which will produce the forms from an excel flat file.

3.4.4.2.2. Software Resources Data Reporting (SRDR)

The SRDR system collects software metrics data to supplement the actual Contractor Cost Data Reporting (CCDR) data in order to provide a better understanding and improved estimating of software intensive programs. DoD Instruction 5000.02, Enclosure 4, Table 4, establishes SRDR requirements for Acquisition Category I and IA contracts and sub-contracts, regardless of contract type. Detailed procedures and other implementation guidance are found in DoD 5000.04-M-1, "Cost and Software Data Reporting (CSDR) Manual."

3.4.4.2.2.1. Software Resources Data Reporting (SRDR) General Requirements

SRDRs are required on all major contracts and subcontracts, regardless of contract type, for contractors developing/producing software elements within Acquisition Category I and IA programs and pre-Major Defense Acquisition Program and pre-Major Automated Information System programs subsequent to Milestone A approval for any software development element with a projected software effort greater than $20M Then year dollars. The SRDR requirement on high-risk or high-technical-interest contracts priced below $20 million is left to the discretion of the DoD Program Manager (PM) based upon the advice of the Cost Working-level Integrated Product Team (CWIPT). These requirements must also be approved by the Deputy Director, Cost Assessment.

3.4.4.2.2.2. Software Resources Data Reporting (SRDR) Level of Reporting

The program office, in coordination with the CWIPT, may choose to combine a set of smaller releases within a contract into a single release for reporting purposes. Separate software element developments within a single contract may be reported on separately or may be aggregated at the discretion of the DoD PM based upon the advice of the CWIPT.

3.4.4.2.2.3. Software Resources Data Reporting (SRDR) Report Timing

Within 60 days of contract award, the software developer shall submit an SRDR Initial Developer Report for the entire software product, customized as agreed to by the DoD PM in coordination with the CWIPT. The software developer also shall submit an SRDR Initial Developer Report for each deliverable software release or element within 60 days of the beginning of its development. In addition, the software developer shall submit an "as built" SRDR Final Developer Report, customized as agreed to by the CWIPT, within 60 days after delivery of each software release or element to the U.S. Government.

3.4.4.2.2.4. Software Resources Data Reporting (SRDR) Formats and Instructions

SRDR reports consist of the sample SRDR formats which are contained within the report instructions as follows:

- SRDR Sample Format 1, "Software Resources Data Reporting: Initial Government Report"
- SRDR Sample Format 2, "Software Resources Data Report: Initial Developer Report and Data Dictionary"
- SRDR Sample Format 3, "Software Resources Data Report, Final Developer Report and Data Dictionary"

The instructions for the Initial Government Report can be found on the DCARC web site. The instructions for the other two reports are contained in DIDs DI-MGMT-81739 and DI-MGMT-81740, respectively. Links to the official DIDs and the Microsoft Excel templates are also found on the DCARC web site. To note, SRDR formats should be

tailored based upon the way the software developer performs its activities and the related metrics it uses. The three sample SRDR formats are intended as the starting point for developing tailored reports that capture the developer's unique software process.

3.4.4.2.3. Data Collection and Availability

CSDR data is collected and stored in a central repository, the Defense Automated Cost Information Management System (DACIMS), maintained by the DCARC. DACIMS has more than thirty five years of contractor cost data. DACIMS access is easy and quick for all authorized DoD users. The DCARC web site and Chapter 5 of the CSDR Manual, DoD 5000.04-M-1, contain specific registration instructions.

DACIMS may be used to obtain cost data to estimate total program acquisition costs, including work by both contractors and the U.S. Government; total program contract costs, awarded and future, for a particular contractor; and individual contract costs.

Reporting Formats and Instructions. The CSDR system includes two formats and instructions that apply to both CCDRs and SRDRs, four unique CCDRs, and three unique SRDRs. The two CSDRs are shown in this section while the unique reports are covered in the separate CCDR and SRDR sections. The DD Form 2794, "Cost and Software Data Reporting Plan" (commonly referred to as the "CSDR Plan") describes the proposed collection of data by individual report, by work breakdown structure (WBS) and reporting frequency. The plan must be approved by the Deputy Director, Cost Assessment prior to issuance of a contract solicitation. The Deputy Director, Cost Assessment, may waive the information requirements prescribed in Table 4 in Enclosure 4 of DoDI 5000.02. The format for the Contract Work Breakdown Structure is contained within the Data Item Description (DID) (DI-MGMT-81334, current edition). The CSDR Plan format and instructions and the link to the official DID can be found at the DCARC web site.

Training. The DCARC provides periodic CSDR training at various sites throughout CONUS for both government and contractor personnel. DCARC strongly encourages stakeholders to attend these training sessions and schedules classes to meet stakeholder requirements. The training schedule and various training materials can also be found at the DCARC web site.

3.4.4.3. Operating and Support (O&S) Cost Data

Historical O&S cost data for currently fielded systems are available from the Visibility and Management of Operating and Support Costs (VAMOSC) data system managed by each DoD military service. The data can be displayed in several different formats, including the Office of Cost Assessment standard cost element structure described previously. Data can be obtained for entire systems, or at lower levels of detail. VAMOSC provides not only cost data, but related non-cost data (such as operating tempo or maintenance man-hours) as well. This type of data is useful for analogy

estimates (between proposed systems and appropriate predecessor or reference systems) and for "bottoms-up" engineering estimates (for fielded systems or components, possibly adjusted for projected reliability and maintainability growth). VAMOSC data should always be carefully examined before use in a cost estimate. The data should be displayed over a period of a few years (not just a single year), and stratified by different sources (such as major command or base). This should be done so that abnormal outliers in the data can be identified, investigated, and resolved as necessary.

3.4.4.4. Visibility and Management of Operating and Support Costs (VAMOSC)

To achieve visibility into the Operating and Support (O&S) costs of major fielded weapon systems, DoD requires that each military service will maintain an historical data collection system that collects O&S data in a standard presentation format. The Office of Cost Assessment provides policy guidance on this requirement, known as the VAMOSC program, and monitors its implementation by each of the military services. Each service has its own unique VAMOSC data system that tracks actual O&S cost experience for major weapon systems. The data can be displayed by time frame, at various levels of detail, and by functional elements of cost (such as depot maintenance, fuel, consumable items, and so forth). Each VAMOSC system provides not only cost data, but related non-cost data (such as system quantities, operating tempo, or maintenance man-hours) as well. VAMOSC data can be used to analyze trends in O&S cost experience for each major system, as well as to identify and assess major cost drivers. In addition, VAMOSC data are important as a data source for cost estimates of future systems, since cost estimates for future systems are often made by analogy to appropriate predecessor systems. DoD 5000.04-M, "DoD Cost Analysis Guidance and Procedures," Section 8, provides additional direction for VAMOSC.

3.5. Manpower Estimates

3.5. Manpower Estimates

For major defense acquisition programs, manpower estimates are required by

- (1) 10 U.S.C. 2434, which directs the Secretary of Defense to consider an estimate of the personnel required to operate, maintain, support, and provide system-related training in advance of approval of the development, or production and deployment; and
- (2) DoD Instruction 5000.02, Enclosure 4, Table 2-1, which directs development of a manpower estimate at Milestones B, C, and full-rate production.

Manpower estimates serve as the authoritative source for out-year projections of active-duty and reserve end-strength, civilian full-time equivalents, and contractor support work-years. As such, references to manpower in other program documentation should be consistent with the manpower estimate once it is finalized. In particular, the

manpower estimates should be consistent with the manpower levels assumed in the final Affordability Analysis and the Cost Analysis Requirements Description (CARD).

Organizational responsibilities in preparing the manpower estimate vary by DoD Component. Normally, the manpower estimate is prepared by an analytic organization in the DoD Component manpower community, in consultation with the program manager. The manpower estimates are approved by the DoD Component manpower authority (for the military departments, normally the Assistant Secretary for Manpower and Reserve Affairs).

For Acquisition Category ID programs, a preliminary manpower estimate should be made available at least six months in advance of the Defense Acquisition Board (DAB) milestone review, and should be reflected in the draft CARD due at that time, in order to support the development of cost estimates and affordability analyses. The final manpower estimate should be fully staffed and submitted to the Under Secretary of Defense for Personnel and Readiness (USD(P&R)) in sufficient time to support the Overarching Integrated Product Team (OIPT) review in preparation of the DAB meeting. Normally this would be four weeks prior to the OIPT review meeting. The USD(P&R) staff will review the final manpower estimate and provide comments to the OIPT.

The exact content of the manpower estimate is tailored to fit the particular program under review. A sample format for the manpower estimate is displayed in the Table 3.5.T1 below. In addition, the estimate should identify if there are any resource shortfalls (i.e., discrepancies between manpower requirements and authorizations) in any fiscal year addressed by the estimate. Where appropriate, the manpower estimate should compare manpower levels for the new system with those required for similar legacy systems, if any. The manpower estimate also should include a narrative that describes the scope of each functional area (operations, maintenance, support, and training), and the methods, factors, and assumptions used to estimate the manpower for each functional area. See section 6.3.1.2 and section 6.3.1.3 for further information concerning manpower.

Table 3.5.T1. Sample Manpower Estimate Format MANPOWER ESTIMATE (Program Title) SERVICE

	FYxx [2]	FYxx+1	FYxx+2	FYxx+3	FYxx+4	... [3]
OPERATE: [4] Military Officers Enlisted Civilian Contractor Sub-Total						
MAINTAIN: [4] Military Officers Enlisted Civilian						

[1] Provide separate estimates for Active and Reserve Components for each Service.
[2] Report manpower by fiscal year (FY) starting with initial fielding and continuing through retirement and disposal of the system (to include environmental clean-up).
[3] Until fielding is completed.
[4] Provide estimates for manpower requirements and authorizations. Provide deltas between requirements and authorizations for each fiscal year.

Contractor Sub-Total						
SUPPORT: [4] Military Officers Enlisted Civilian Contractor Sub-Total						
TRAIN: [4] Military Officers Enlisted Civilian Contractor Sub-Total						
TOTAL						

3.6. Major Automated Information Systems Economic Analysis

3.6.1. Introduction

An automated information system (AIS) is a system of computer hardware, computer software, data and/or telecommunications that performs functions such as collecting, processing, storing, transmitting and displaying information; however, systems that are an integral part of a weapon or weapon system are excluded from this definition. AIS programs that meet the specified dollar thresholds in DoD Instruction 5000.02, Enclosure 3, Table 1, qualify as major automated information system (MAIS) programs. MAIS programs that are subject to review by OSD at the Defense Acquisition Board

(DAB) are designated Acquisition Category (ACAT) IAM. Other MAIS programs, delegated to the head of the DoD Component or the appropriate DoD Component Acquisition Executive, are designated ACAT IAC. In some cases, an ACAT IA program also meets the definition of a Major Defense Acquisition Program (MDAP). In these cases, the Secretary of Defense may designate that the program be treated only as a MAIS program or only as a major defense acquisition program (MDAP). Generally, a program that requires the development of customized hardware shall be treated only as a MDAP, and a program that does not require the development of customized hardware shall be treated only as a MAIS program.

DoD Instruction 5000.02, Enclosure 4, Table 2-1, requires that an Economic Analysis be performed in support of the Milestone A, Milestone B, and full-rate production decision (or equivalent) reviews. The purpose of the Economic Analysis is to determine the best MAIS program acquisition alternative by assessing the net costs and benefits of the proposed MAIS program relative to the status quo. In general, the best alternative will be the one that meets validated capability needs at the lowest life-cycle cost (measured in net present value terms), and/or provides the most favorable return on investment.

Whenever an Economic Analysis is required, the DoD Component responsible for the program also may be required to provide a DoD Component Cost Analysis, which is an independent estimate of program life-cycle costs. Normally, the Economic Analysis is prepared by the MAIS program office, and the DoD Component Cost Analysis is prepared by an office or entity not associated with the program office or its immediate chain of command. The need for a DoD Component Cost Analysis at Milestone A is evaluated for each program in tailoring the oversight process.

The Economic Analysis should be accomplished in accordance with DoD Instruction 7041.3, "Economic Analysis for Decision Making." Normally, the DoD Component submits a Final Cost/Benefit Position that resolves the differences between the Economic Analysis and the Component Cost Analysis. Also, the Component and the MDA should address any differences between the Final Cost/Benefit Position and the funding in the current Future Years Defense Program.

In addition to an Economic Analysis, independent cost estimates are occasionally required for MAIS programs. Per 10 U.S.C. 2445c, MAIS programs where the MDA is USD(AT&L) (ACAT IA) that experience critical program changes must undergo an independent cost estimate (ICE) prepared by the Director of Cost Assessment and Program Evaluation (DCAPE). ICEs will also be conducted for MAIS programs at any other time considered appropriate by DCAPE, or upon request by USD(AT&L) (see 10 U.S.C. 2334). Additionally, DCAPE develops an ICE for MAIS Defense Business Systems when the Deputy Chief Management Officer or DoD Chief Information Officer is the MDA and a critical change, as defined in 10 U.S.C. 2445c, has occurred.

3.6.2. Office of Cost Assessment and Program Evaluation Review Procedures

For Acquisition Category IAM programs, both the Economic Analysis and the DoD Component Cost Analysis are subject to independent review and assessment by the Director, Cost Assessment and Program Evaluation (DCAPE).

The purpose of the DCAPEs assessment is to provide the Milestone Decision Authority with an independent determination that (1) the estimates of life-cycle costs and benefits are reasonable, traceable, and reflect DoD policy and DCAPE guidance on the consideration of life-cycle costs, (2) the return on investment calculation is valid, and (3) the cost estimates are built on realistic program and schedule assumptions.

During the review process, DCAPE staff may engage in discussion with the DoD Components regarding any discrepancies related to MAIS cost estimates and comment on deficiencies regarding the methodology or execution of cost estimates. Furthermore, DCAPE staff are authorized to concur with the choice of a cost estimate used to support the acquisition program baseline (APB) as well as in the selection of a proper confidence interval for the MAIS program.

DCAPE and the Secretary of the Military Department concerned are required by Congress to report certain elements of program cost risk for MAIS programs. For such programs, DCAPE and the Secretary of the Military Department concerned (or the head of the Defense Agency concerned) must state the confidence level used in establishing a cost estimate, the rationale for selecting the confidence level, and ensure that the confidence level provides a high degree of confidence that the program can be completed without the need for significant adjustment to program budgets.

The confidence level disclosure shall be included in the ADM approving the APB and in any other cost estimates for MAIS programs prepared in association with this section.

3.6.2.1. Kick-Off Meeting

The review process normally begins with a kick-off meeting held with DCAPE staff, representatives from the Major Automated Information System (MAIS) program office, the DoD Component Cost Analysis Team, and any DoD Component functional or headquarters sponsors. The purpose of the meeting is to reach a common understanding on the expectations for the upcoming activities and events leading to the Information Technology Acquisition Board milestone review. As a starting point, the DoD Component staff and/or sponsors' representatives should review the contents of the most recently approved capability needs documents, and explain any prior analysis (such as a Capabilities-Based Assessment) used to justify the need for a materiel solution (that will be met by the MAIS program).

At the kick-off meeting, the DoD Component staff and/or sponsors' representatives also should be prepared to explain the planned approach for the upcoming Economic Analysis. To facilitate this dialogue, the MAIS program office should prepare and provide a brief Economic Analysis development plan. The development plan should document the organizational responsibilities, analytic approach, ground rules and

assumptions, and schedule for the economic analysis. The development plan should identify the specific alternatives that will be compared in the Economic Analysis. Normally, at least one alternative should be associated with the proposed MAIS program, and one alternative should be associated with the status quo (no modernization investment). It may well be the case that the status quo alternative represents an unacceptable mission posture-it may cost too much to sustain, be unable to meet critical capability needs, or be unsupportable due to technological obsolescence. Nevertheless, the status quo concept, applied over the same time frame (Life Cycle) as the proposed MAIS program, is used for comparative purposes in the Economic Analysis. The Economic Analysis development plan should document the DoD Component Cost Analysis approach and schedule as well.

As part of the Economic Analysis development plan, the program office should propose the cost element structure that will be used to organize and categorize cost estimates in the Economic Analysis. The cost element structure provides a hierarchal framework of defined cost elements that in total comprise the program life-cycle cost. The cost element structure should include phase-out costs associated with the status quo (legacy or predecessor) system. These costs would be incurred in managing, preserving, and maintaining the operations of the status quo system as it runs parallel to the phasing in of the new system. The status quo phase-out cost elements are not used in the estimate of the status quo alternative. A sample of a generic cost element structure is available from DCAPE staff. DCAPE can also provide advice on a consistent approach to net present value and return on investment computations.

3.6.2.2. Use of the Cost Analysis Requirements Description (CARD) for Major Automated Information System (MAIS) Programs

As soon as possible after the kick-off meeting, the draft Cost Analysis Requirements Description (CARD) is provided to DCAPE staff for review. The CARD is used to define and describe the MAIS program for purposes of preparing both the Economic Analysis and the DoD Component Cost Analysis. For a MAIS program, the CARD typically would address the following elements:

- Program description;
- Program operational concept;
- Program data management requirements;
- Program quantity requirements;
- Program manpower requirements;
- Program fielding strategy;
- Program milestone schedule; and
- Program acquisition plan or strategy.

Procedures for the preparation of the CARD are described in DoD Instruction 5000.02, Enclosure 7, paragraph 2. Additional guidelines on CARD preparation are found in DoD 5000.4 M, "DoD Cost Analysis Guidance and Procedures," Section 1. However, these guidelines are for the most part oriented toward weapon systems and may need to be

tailored somewhat for automated information systems. The system description in the CARD should address both hardware and software elements. The CARD should describe each major hardware item (computers, servers, etc.), noting those items that are to be developed, and those items that are off-the-shelf. The CARD also should describe each software configuration item (including applications as well as support software) and identify those items that are to be developed. For software items to be developed, the CARD should provide (1) some type of sizing information (such as counts of source lines of code, function points, or Reports, Interfaces, Conversions and Enhancements (RICE)-Forms and Workflows (FW) (RICE-(FW) objects) suitable for cost estimating, and (2) information about the programming language and environment. In addition, the CARD should describe any special (physical, information, or operations) system security requirements, if applicable.

Clearly, much of the information needed for the CARD is often available in other program documents. The CARD should stand-alone as a readable document, but can make liberal use of appropriate references to the source documents to minimize redundancy and effort. In such cases, the CARD should briefly summarize the information pertinent to the Economic Analysis in the appropriate section of the CARD, and provide a reference to the source document.

3.6.2.3. Office of Cost Assessment and Program Evaluations CARD Review and Assessment

To facilitate the DCAPE review and assessment, the DoD Component's Economic Analysis and Cost Analysis teams should provide written documentation early enough to permit a timely report to the Overarching Integrated Product Team (OIPT) and Information Technology Acquisition Board. The timeline for document submission is the same as the timeline set forth in Section 3.4.3.1 for major defense acquisition programs. The documentation serves as an audit trail of source data, methods, and results. The documentation should be easy to read, complete and well organized to allow any reviewer to understand the estimate fully. The documentation also serves as a valuable reference for future cost analysts, as the program moves from one acquisition milestone to the next.

After review of the documentation, DCAPE staff provides feedback to the program office and DoD Component staff. Subsequently, DCAPE staff prepares a written report containing the findings of their independent assessment to the Milestone Decision Authority. Depending on the circumstances, the report may contain recommended cost and benefits positions, and it may raise funding or schedule issues. The expectation is that any issues raised have already emerged in prior discussions and that the final DCAPE report should not contain any surprises.

3.7. Principles for Life-Cycle Cost Estimates

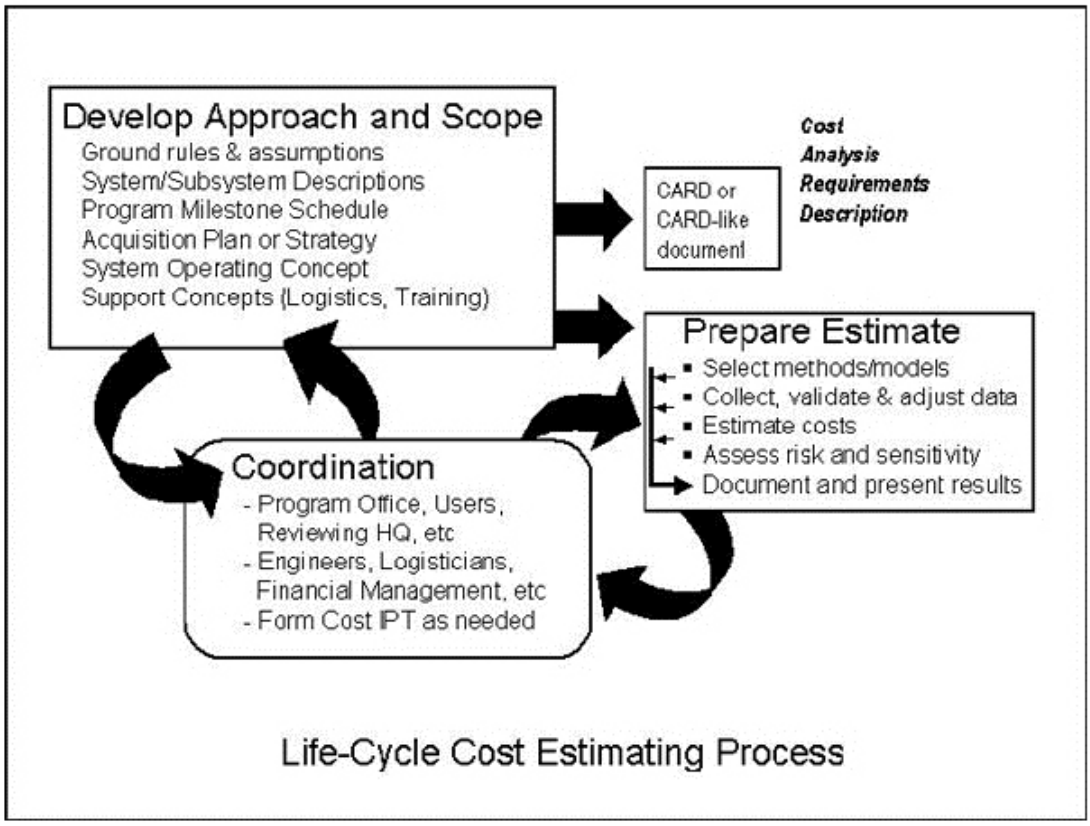
3.7.1. Develop Approach and Scope

3.7. Principles for Life-Cycle Cost Estimates

Section 3.4.3 of this Guidebook primarily focused on procedures associated with life-cycle cost estimates which are subject to review by the Office of Cost Assessment for major defense acquisition programs. The estimate is prepared in support of major milestone or other program reviews held by the Defense Acquisition Board. This section is intended to be more generally applicable and somewhat more analytic in nature. It describes a recommended analytic approach for planning, conducting, and documenting a life-cycle cost estimate for a defense acquisition program (whether or not the estimate is subject to Office of Cost Assessment review). Much of the discussion in this section was written with the less experienced cost analyst in mind.

The recommended analytic approach for preparing a life-cycle cost estimate is shown in Figure 3.7.F1:

Figure 3.7.F1. A Recommended Analytic Approach for Life-Cycle Cost Estimates



The next few sections describe this process.

3.7.1. Develop Approach and Scope

The first step in preparing a credible cost estimate is to begin with the development of a sound analytic approach. During this planning phase, critical ground rules and assumptions are established, the scope of the estimate is determined, and the program to be costed is carefully defined and documented. The program definition includes not only a technical and physical description of the system (and perhaps major subsystems), but also a description of the system's program schedule, acquisition strategy, and operating and support concepts. In some cases, it is necessary to state explicitly the costs to be included, and the costs to be excluded. For example, when systems have complex interfaces with other systems or programs (that are outside the scope of the system being costed), the interfaces should be carefully defined.

For programs that will be reviewed by the Office of Cost Assessment, the program office is required to define its program in a comprehensive formal written document known as a Cost Analysis Requirements Description (CARD). The format for this document is briefly summarized in section 3.4.4.1 of this Guidebook, and is completely described in DoD 5000.4 M, "DoD Cost Analysis Guidance and Procedures," Section 1. Much of the necessary information to prepare a written program description can be extracted and synthesized from common program source documents and contract specifications. The written program description should stand-alone as a readable document, but can make

liberal use of suitable references to the source documents to minimize redundancy and effort.

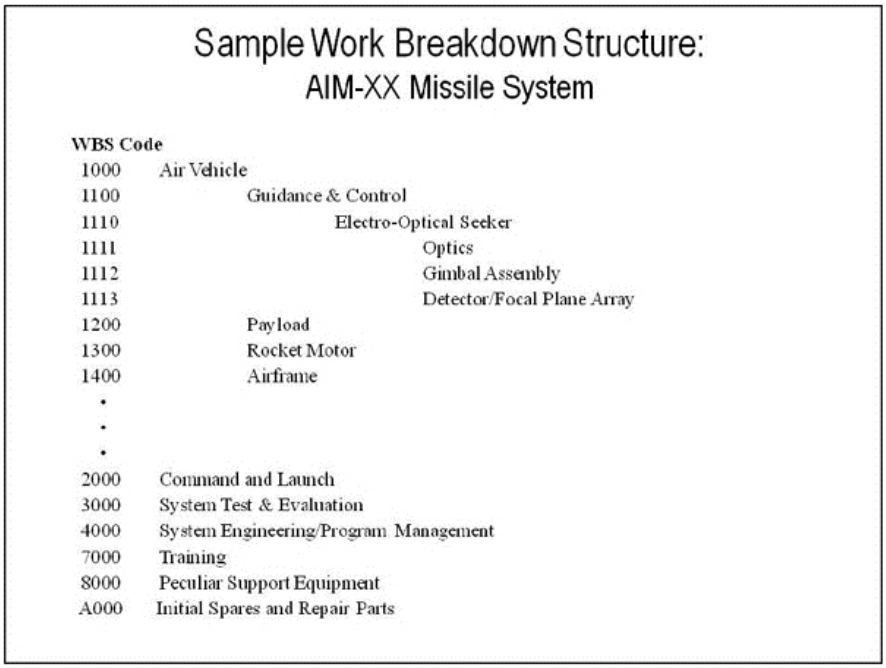
It is important that the analytic approach to the cost estimate be documented and reviewed by all potentially interested parties, before the actual work on preparing the cost estimate begins. This helps ensure that there are no false starts or misunderstandings later in the process.

3.7.1.1. Work Breakdown Structure (WBS)

Part of the system definition typically includes the program work breakdown structure. The program WBS is a hierarchy of product-oriented elements (hardware, deliverable software, data, and services) that collectively comprise the system to be developed or produced. The program WBS relates the elements of work to each other and to the end product. The program WBS is extended to a contract WBS that defines the logical relationship between the elements of the program and corresponding elements of the contract work statement. The WBS provides the framework for program and technical planning, cost estimating, resource allocation, performance measurement, technical assessment, and status reporting. In particular, the contract WBS provides the reporting structure used in contract management reports or reports in the Contractor Cost Data Reporting system. Further information about the WBS can be found in MIL-STD-881C, Work Breakdown Structures for Defense Materiel Items, which is available at the Defense Cost and Resource Center web site.

A sample of the WBS for an air-to-air tactical missile is provided in Figure 3.7.1.1.F1

Figure 3.7.1.1.F1. Sample Work Breakdown Structure



3.7.1.2. Cost Estimating Functional Categories

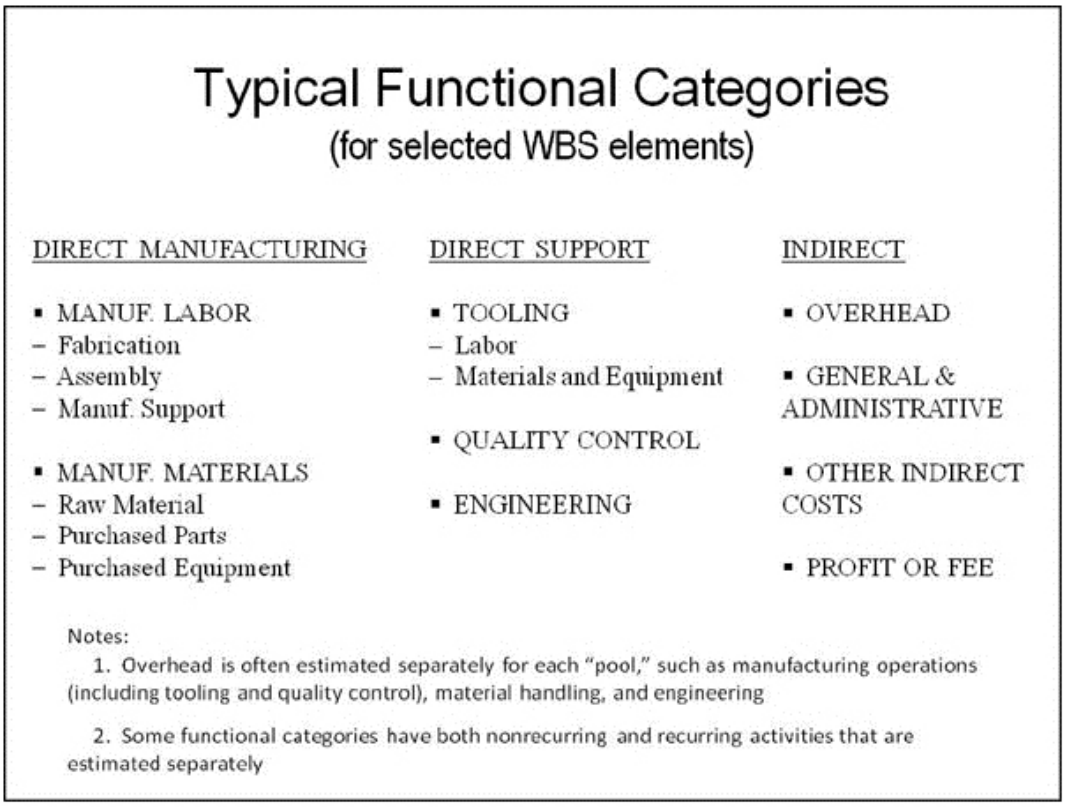
In most cost estimates, selected WBS elements (usually high cost) often are further broken down into functional categories. A typical structure for the functional categories is provided in Figure 3.7.1.2.F1. In the tactical missile example discussed in the last section, most likely the cost estimate for the Airframe WBS element would be broken down by functional category, whereas the cost estimate for the Initial Spares and Repair Parts WBS element most likely would be estimated at the level of total cost, and not by functional category.

Standard terms and definitions for the various functional categories were developed to support the Cost and Software Data Reporting system (see section 3.4.4.2). The terms and definitions used in Figure 3.7.1.2.F1 can be found in the following:

- DoD 5000.04-M-1, "Cost and Software Data Reporting (CSDR) Manual"
- Data Item Description DI-FNCL-81565B, "Cost Data Summary Report (DD Form 1921)"
- Data Item Description DI-FNCL-81566B, "Functional Cost-Hour Report (DD Form 1921-1)"

All of these are available at the Defense Cost and Resource Center web site.

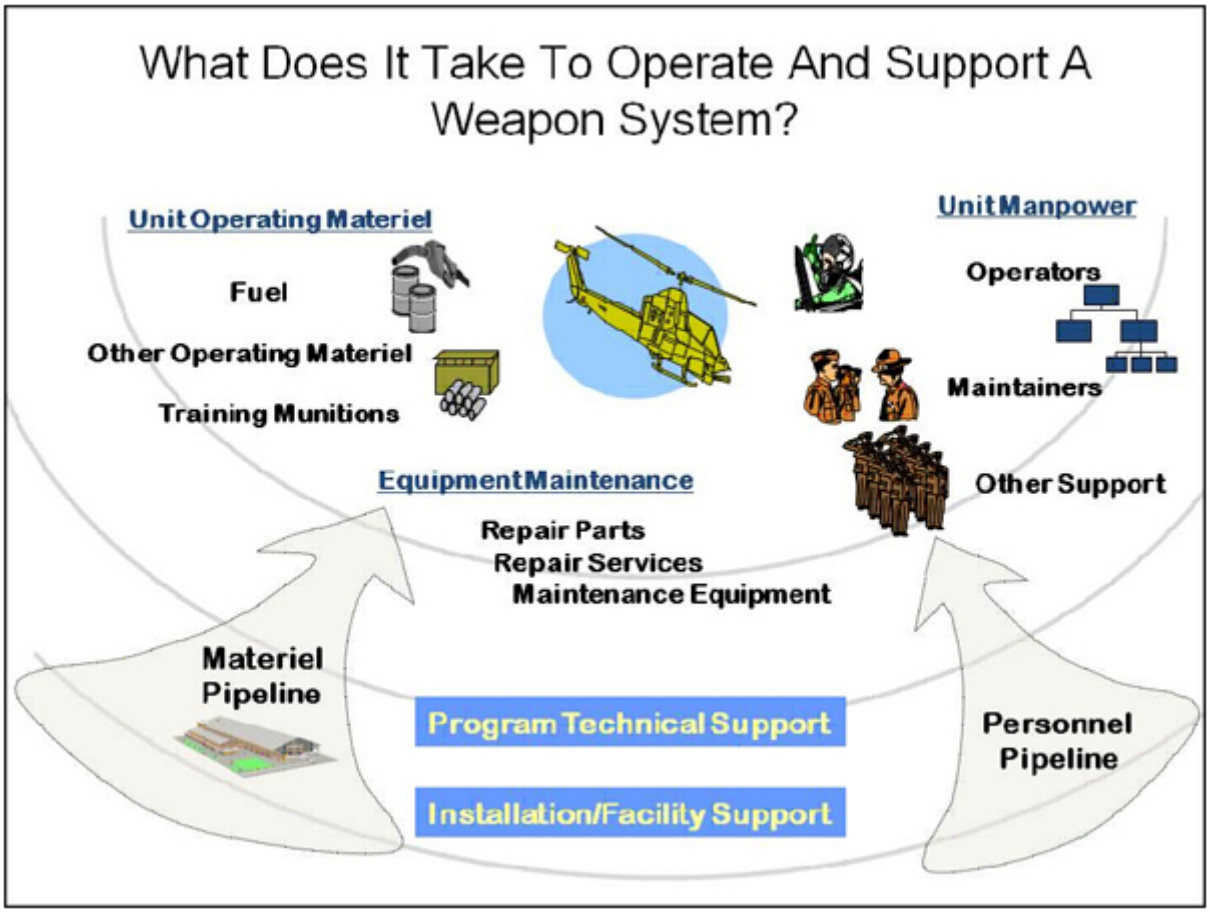
Figure 3.7.1.2.F1. Functional Categories for Cost Estimating



3.7.1.3. Operating and Support (O&S) Cost Element Structure

Another step in developing the analytic approach to the cost estimate is establishing the cost element structure that will be used as the format for the O&S cost estimate. The cost element structure describes and defines the specific elements to be included in the O&S cost estimate in a disciplined hierarchy. Using a formal cost element structure (prepared and coordinated in advance of the actual estimating) identifies all of the costs to be considered, and organizes the estimate results. The cost element structure is used to organize an O&S cost estimate similar to the way that a work breakdown structure is used to organize a development or procurement cost estimate. The intent is to capture all costs of operating, maintaining, and supporting a fielded system (and its associated manpower and facilities). A notional portrayal of these costs, organized into a cost element structure format, is provided in Figure 3.7.1.3.F1. Note that the use of a cost element structure provides considerably more detail than simply using budget appropriation categories (operations and maintenance, military personnel).

Figure 3.7.1.3.F1. O&S Costs Organized by a Cost Element Structure



A standard cost element structure used by the Office of Cost Assessment was introduced in section 3.1.3.3. Details can be found in the OSD CAPE O&S Cost-

Estimating Guide. Although each DoD Component (military department or defense agency) may have its own preferred cost element structure, it is expected that each DoD Component will have a cross walk or mapping so that any presentation to the Office of Cost Assessment can be made using the standard structure.

3.7.2. Prepare the Estimate

This section describes the typical steps in preparing a life-cycle cost estimate. The discussion summarizes the steps entailed in selecting estimating techniques or models, collecting data, estimating costs, and conducting sensitivity or risk analysis.

In addition, the importance of good documentation of the estimate is explained.

3.7.2.1. Select Methods and/or Models

A number of techniques may be employed to estimate the costs of a weapon system. The suitability of a specific approach will depend to a large degree on the maturity of the program and the level of detail of the available data. Most cost estimates are accomplished using a combination of the following estimating techniques:

- **Parametric.** The parametric technique uses regression or other statistical methods to develop Cost Estimating Relationships (CERs). A CER is an equation used to estimate a given cost element using an established relationship with one or more independent variables. The relationship may be mathematically simple or it may involve a complex equation (often derived from regression analysis of historical systems or subsystems). CERs should be current, applicable to the system or subsystem in question, and appropriate for the range of data being considered.

- **Analogy.** An analogy is a technique used to estimate a cost based on historical data for an analogous system or subsystem. In this technique, a currently fielded system, similar in design and operation to the proposed system, is used as a basis for the analogy. The cost of the proposed system is then estimated by adjusting the historical cost of the current system to account for differences (between the proposed and current systems). Such adjustments can be made through the use of factors (sometimes called scaling parameters) that represent differences in size, performance, technology, and/or complexity. Adjustment factors based on quantitative data are usually preferable to adjustment factors based on judgments from subject-matter experts.

- **Engineering Estimate.** With this technique, the system being costed is broken down into lower-level components (such as parts or assemblies), each of which is costed separately for direct labor, direct material, and other costs. Engineering estimates for direct labor hours may be based on analyses of engineering drawings and contractor or industry-wide standards. Engineering estimates for direct material may be based on discrete raw material and purchase part

requirements. The remaining elements of cost (such as quality control or various overhead charges) may be factored from the direct labor and material costs. The various discrete cost estimates are aggregated by simple algebraic equations (hence the common name "bottoms-up" estimate). The use of engineering estimates requires extensive knowledge of a system's (and its components') characteristics, and lots of detailed data.

- **Actual Costs.** With this technique, actual cost experience or trends (from prototypes, engineering development models, and/or early production items) are used to project estimates of future costs for the same system. These projections may be made at various levels of detail, depending on the availability of data. Cost estimates that support a full-rate production milestone decision should be based on actual cost data to the greatest extent possible. A common mistake is to use contract prices as a substitute for actual cost experience. Contract prices should not be used to project future costs (even when firm-fixed price) unless it is known that the contract prices are associated with profitable ventures, and that it is reasonable to assume that similar price experience will be obtained for subsequent contracts.

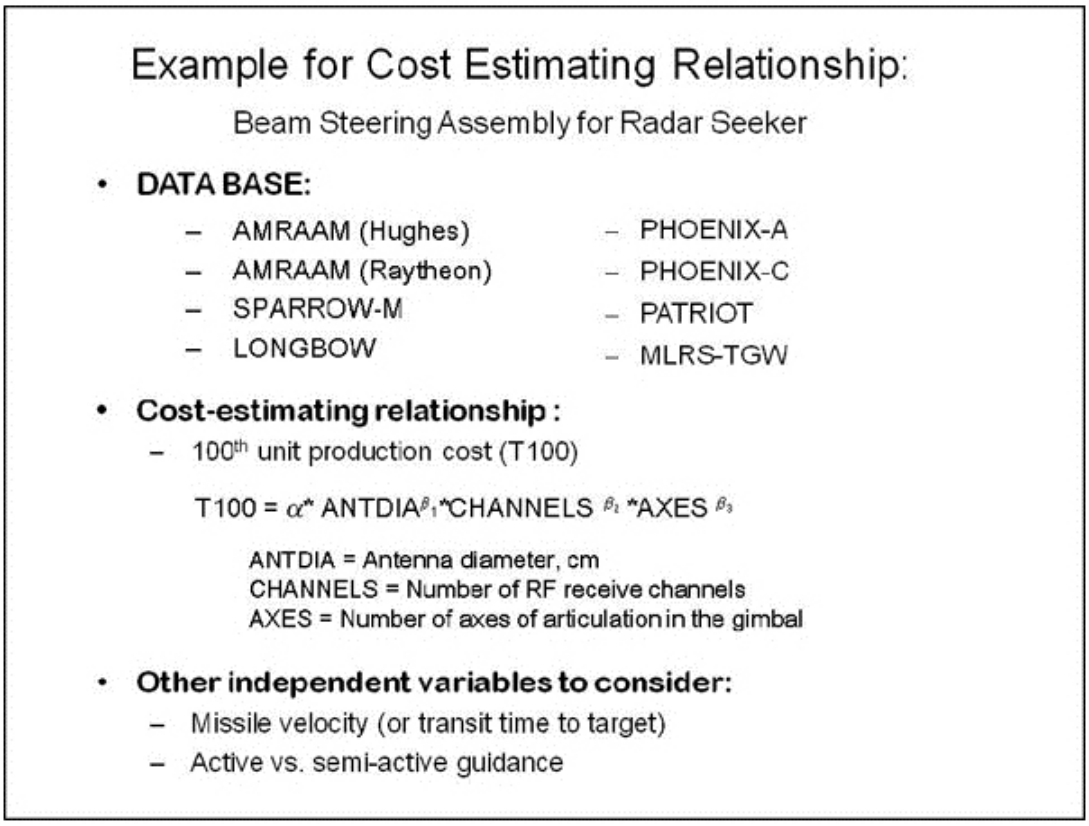
In many instances, it is a common practice to employ more than one cost estimating method, so that a second method can serve as a cross-check to the preferred method. Analogy estimates are often used as cross-checks, even for estimates of mature systems based on actual costs.

The next two sections provide two illustrative examples of common cost estimating techniques.

3.7.2.1.1. Example #1-Cost Estimating Relationship

An exemplar cost estimating relationship is provided in Figure 3.7.2.1.1.F1. The relationship is used to estimate production costs for a component of a tactical missile, using various technical characteristics as independent variables. Developing a good relationship requires not only sound statistical practice, but also considerable experience and insight on the part of the cost analyst. It also requires detailed and well-understood data.

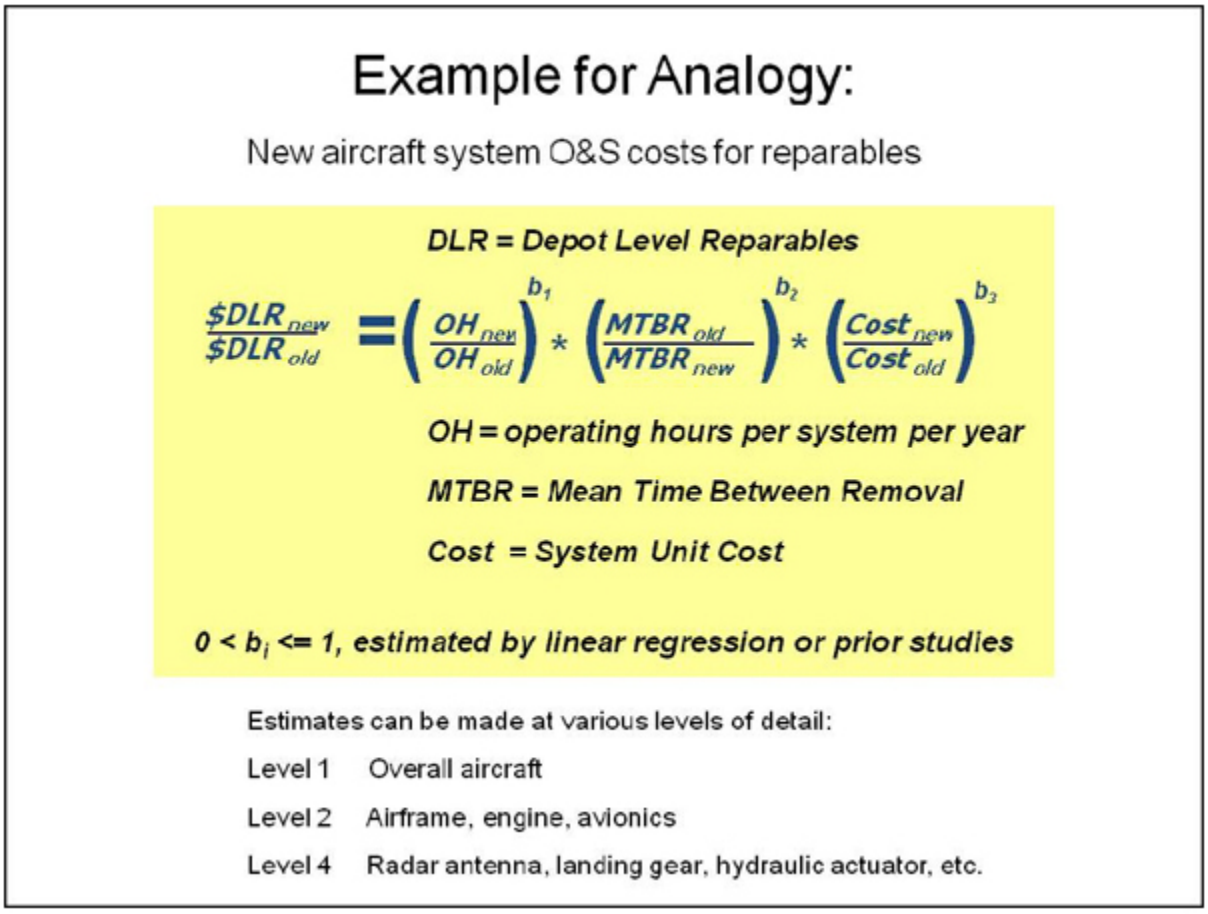
Figure 3.7.2.1.1.F1. Illustrative Cost Estimating Relationship



3.7.2.1.2. Example #2-Analogy

An exemplar cost estimate by analogy is provided in Figure 3.7.2.1.2.F1. In this case, an estimate for one of the Operating and Support (O&S) cost elements (depot level reparables) for a future aircraft system is made by direct analogy to a predecessor aircraft system with a similar mission. Note that the analogy uses scaling parameters for operating (i.e., flying) hours, reliability, and system unit cost. In many analogy estimates, unit cost is often used as a proxy for complexity.

Figure 3.7.2.1.2.F1. Illustrative Cost Estimate by Analogy



3.7.2.2. Collect, Validate, and Adjust Data

There are many possible sources of data that can be used in cost estimates. Regardless of the source, the validation of the data (relative to the purpose of its intended use) always remains the responsibility of the cost analyst. In some cases, the data will need to be adjusted or normalized. For example, in analogy estimates, the reference system cost should be adjusted to account for any differences in system characteristics (technical, physical, complexity, or hardware cost) or operating environment between the reference system and the proposed system being costed.

3.7.2.2.1. Acquisition Cost Data

Actual cost experience on past and current acquisition programs often forms the basis of estimates of future systems. The Cost and Software Data Reporting (CSDR) system is the primary means within the Department of Defense to systematically collect data on the development and production costs and other resource usage incurred by contractors in performing DoD acquisition program contracts associated with major defense acquisition programs. DoD Instruction 5000.02 makes CSDR reporting mandatory for all major contracts and subcontracts, regardless of contract type valued at more than $50 million (then-year dollars). Program managers use the CSDR system

to report data on contractor development, production, and sustainment costs and resource usage incurred in performing DoD programs. Further, the Defense Federal Acquisition Regulation Supplement (DFARS) establishes requirements for CSDR Reporting to be included in the proposals and contract performance for major acquisition programs (MDAPs) and Major Automated Information Systems (MAIS). Additional information on cost data reporting is found in section 3.4.4.2. of this Guidebook.

3.7.2.3. Estimate Costs

With the completion of the steps described earlier in this chapter, the actual computations of the cost estimate can begin. It is important to assess critically the outputs from the estimating methods and models, drawing conclusions about reasonableness and validity. Peer review is often helpful at this point. For complex cost estimates, with many elements provided from different sources, considerable effort and care are needed to deconflict and synthesize the various elements.

3.7.2.4. Assess Risk and Sensitivity

For any system, estimates of future life-cycle costs are subject to varying degrees of uncertainty. The overall uncertainty is not only due to uncertainty in cost estimating methods, but also due to uncertainties in program or system definition or in technical performance. Although these uncertainties cannot be eliminated, it is useful to identify associated risk issues and to attempt to quantify the degree of uncertainty as much as possible. This bounding of the cost estimate may be attempted through sensitivity analyses or through a formal quantitative risk analysis.

Sensitivity analysis attempts to demonstrate how cost estimates would change if one or more assumptions change. Typically, for the high-cost elements, the analyst identifies the relevant cost-drivers, and then examines how costs vary with changes in the cost-driver values. For example, a sensitivity analysis might examine how maintenance manning varies with different assumptions about system reliability and maintainability values, or how system manufacturing labor and material costs vary with system weight growth. In good sensitivity analyses, the cost-drivers are not changed by arbitrary plus/minus percentages, but rather by a careful assessment of the underlying risks. Sensitivity analysis is useful for identifying critical estimating assumptions, but has limited utility in providing a comprehensive sense of overall uncertainty.

In contrast, quantitative risk analysis can provide a broad overall assessment of variability in the cost estimate. In risk analysis, selected factors (technical, programmatic and cost) are described by probability distributions. Where estimates are based on cost models derived from historical data, the effects of cost estimation error may be included in the range of considerations included in the cost risk assessment. Risk analysis assesses the aggregate variability in the overall estimate due to the variability in each input probability distribution, typically through Monte-Carlo simulations. It is then possible to derive an estimated empirical probability distribution for the overall life-cycle

cost estimate. This allows the analyst to describe the nature and degree of variability in the estimate.

Sensitivity and risk analyses also have uses beyond addressing the uncertainty in cost estimates. They also can be used to help better understand what can go wrong with a program, and focus appropriate management attention to risk areas that are concerns. The history of DoD weapon system acquisition would indicate that cost growth and schedule delays can occur as a direct result of one or more of the following concerns:

- Immaturity of critical technologies at the start of development
- Inadequate understanding of design challenges at the start of development (often due to the absence of prototyping)
- Requirements uncertainty, instability, or creep
- Failure to acknowledge (or deal with) funding shortfalls
- Funding instability in the programming, budgeting or appropriations process
- Failure to detect (or deal with) unrealistic contractor cost proposals in competitive source selections (from either the prime or major subcontractors)
- Excessive concurrency between development and procurement schedules
- Inadequate understanding of software development size and integration challenges
- Failure to achieve design stability by the time of the critical design review
- Failure to achieve stable manufacturing processes by the time of early production

3.7.2.5. Document and Present Results

A complete cost estimate should be formally documented. The documentation serves as an audit trail of source data, methods, and results. The documentation should be easy to read, complete and well organized-to allow any reviewer to understand the estimate fully. The documentation also serves as a valuable reference for future cost analysts, as the program moves from one acquisition milestone to the next.

The documentation should address all aspects of the cost estimate: all ground rules and assumptions; the description of the system and its operating and support concepts; the selection of cost estimating methods; data sources; the actual estimate computations; and the results of any sensitivity or risk analyses. The documentation for the ground rules and assumptions, and the system description, should be written as an updated (final) version of the Cost Analysis Requirements Description (CARD) or CARD-like document described earlier. The documentation for the portion of the cost estimate dealing with data, methods, and results often is published separately from the CARD or CARD-like document, but if that is the case, the two documents should be completely consistent.

3.7.3. Coordination

Managing the preparation of a life-cycle cost estimate requires continual coordination among all of the stakeholders. Normally, cost estimates are sponsored by a system

program office and are prepared by a multi-disciplinary team with functional skills in financial management, logistics, engineering, and other talents. The team also should include participants or reviewers from major affected organizations, such as the system's operating command, product support center, maintenance depot, training center or command, and so forth. Typically, the analytic approach to the cost estimate is documented in a written study plan that includes a master schedule (of specific tasks, responsible parties, and due dates). For sufficiently complex efforts, the estimating team may be organized as a formal Integrated Product Team. Throughout the preparation of the estimate, coordination with all interested parties remains important. Frequent in-progress reviews or meetings are usually a good practice.

For independent cost estimates, the team may be smaller and less formal, but the basic principle-complete and continual coordination of the cost estimate with all interested parties-still applies.

3.7.4. Further Information and Training

3.7.4. Further Information and Training

The Acquisition Community Connection website has additional information on cost analysis.

In addition, the Defense Acquisition University offers the following courses in residence:

- BCF 106 -- Fundamentals of Cost Analysis
- BCF 107 -- Applied Cost Analysis
- BCF 204 -- Intermediate Cost Analysis
- BCF 206 -- Cost/Risk Analysis
- BCF 208 -- Software Cost Estimating
- BCF 215 -- Operating and Support Cost Analysis

As well as the following courses as on-line continuous learning modules:

- CLB 007 - - Cost Analysis
- CLM016 - - Cost Estimating
- CLB024 - - Cost Risk Analysis Introduction

In addition, each year the Cost Assessment Office sponsors a Department of Defense Cost Analysis Symposium. This symposium includes presentations from government and support contractor cost analysts concerning best practices and state-of-the-art in cost estimating. The Symposium also features senior distinguished speakers and panelists from government, industry, and academia. Further information may be found at the DoD Cost Analysis Symposium web site.