# 14

# COST AS AN INDEPENDENT VARIABLE (CAIV)

*" War is not, as some seem to suppose, a mere game of chance. Its principles constitute one of the most intricate of modern sciences."*

General Henry W. Halleck,
*Elements of Military Art and Science*, Third ed. (1863)

## 14.1 POLICY

The acquisition strategy shall address methodologies to acquire and operate affordable DoD systems by setting aggressive, achievable cost objectives and managing achievement of these objectives. Cost objectives shall be set to balance mission needs with projected out-year resources, taking into account anticipated process improvements in both DoD and defense industries.

### 14.1.1 Cost/Performance Tradeoffs

Cost reductions are accomplished through cost/performance tradeoff analyses, which shall be conducted before an acquisition approach is finalized. To facilitate that process, the Overarching Integrated Product Team (OIPT) for each Acquisition Category (ACAT) I and IA (as required) program establishes a Cost/Performance IPT (CPIPT). The user community is represented on the CPIPT. Industry representation, consistent with statute and at the appropriate time, is also considered.

## 14.2 COST AS AN INDEPENDENT VARIABLE (CAIV)

### 14.2.1 Discussion

An initiative to reduce life-cycle costs of systems is called Cost As an Independent Variable (CAIV). Thus, performance and schedule are a function of available (budgeted) resources. CAIV was proposed in 1995 and implemented in March of 1996 as part of the 5000-series directives on defense weapons systems acquisition. Implementation is directed for all Major Defense Acquisition Programs (MDAPs) in Concept Development or Program Definition and Risk Reduction phases and selected programs beyond that point. The CAIV concepts will be of value to all acquisition programs and has particular application to logistics as a major driver of life-cycle costs.

Two DoD working groups have led the definition and implementation of CAIV. A Defense Manufacturing Council (DMC) Working Group developed a CAIV working group

report disseminated in December 1995, which describes a strategy for setting aggressive, realistic cost objectives for acquiring defense systems and managing the associated risks. In June 1996, the Flagship Programs Workshops began meeting under the leadership of the Office of the Under Secretary of Defense (Acquisition and Technology) (OUSD (A&T)). The participants include representatives of eight defense programs as well as representatives of the Office of the Secretary of Defense (OSD), Institute for Defense Analyses (IDA), and the Defense Systems Management College (DSMC).

Continuing this momentum in 1997, a DMC planning team recommended that the old council be sustained under a new name, the Defense Systems Affordability Council (DSAC). Under this new name, DMC work was continued, but with a new organization and a new mode of operation. DSAC's two major thrusts were to (1) continue DMC momentum on ongoing acquisition reform initiatives including CAIV and (2) conduct an integrated acquisition logistics attack on life-cycle cost. The first DSAC meeting was held 2 June 1997.

Figure 14-1 provides a listing of the eight flagship programs. Those eight programs were (1996/97) sharing problems and solutions in implementing CAIV policy. This section looks at the definitions, concepts, processes, and risks of CAIV with examples from the Flagship Programs.

14.2.1.1 Definition. CAIV is a new (1995) DoD strategy that makes total life-cycle cost, as projected within the new acquisition environment, a key driver of system requirements, performance characteristics, and schedules. This is a 180-degree conceptual change in thinking from the days of requirements, performance, and sometimes schedule-driving costs. While the life-cycle cost/performance/requirements tradeoff process is the heart of CAIV, a broader definition is necessary to recognize the environment in which these trades take place. Programs are being aggressively managed to meet program objectives concomitantly with the implementation of reform initiatives such as use of commercial specifications and practices, Integrated Product and Process Development (IPPD) Teams, and contractor enterprise re-engineering. The acquisition reform initiatives have the potential to significantly reduce cost and change the baseline against which the cost/performance/requirements trades are to be benchmarked. The description of CAIV within this broader context as provided in the *Defense Acquisition Deskbook* is, "CAIV is a strategy that entails setting aggressive, yet realistic cost objectives when acquiring defense systems and managing achievement of these objectives. Cost objectives must balance mission needs with projected out-year resources, taking into account existing technology, maturation of new technologies and anticipated process improvements in both DoD and industry." In some ways CAIV suffers from the combination of too many initiatives to be easily explained. Philosophically CAIV is the combination of all the best practices affecting cost.

| PROGRAM | PROGRAM DESCRIPTION | PROGRAM STATUS |
|---|---|---|
| EELV | A more cost-effective space launch vehicle for medium and heavy lift requirements | Pre-Engineering and Manufacturing Development (EMD) phase, start Dec. 1996 |
| AIM-9X | Next generation Sidewinder air-to-air missile | EMD start Jan. 1997 |
| TACMS-BAT P31 | Upgrade of tactical ground-to-ground missile – new seeker | Currently in Program Definition and Risk Reduction (PDRR), EMD start in 1998 |
| MIDS | Third generation secure, jam-resistant, communication system for NATO family | EMD contract awarded in Mar. 1994; restructured June 1994; CDR in-process |
| JASSM | Long-range air-to-surface standoff missile | Entering 2-year competitive PDRR |
| CRUSADER | 155MM self-propelled Howitzer and armored re-supply vehicle | Completion of PDRR in FY 2000; single contract team |
| JSF | Advance Strike Fighter Aircraft | Pre-PDRR |
| SBIRS | Space-based infrared surveillance system for missile defense | Entered EMD for GEO in FY 1996; PDRR for LEO with MS II in FY 1999 |

**Figure 14-1: CAIV Flagship Programs**
(As of 21 October 1996)

14.2.1.2 Concepts. The implementation of CAIV requires new thinking about program management. If cost is truly to be the key driver of performance and schedule, no single cost-reduction strategy is likely to be sufficient. All cost-reduction initiatives must be considered. In a presentation by the Institute for Defense Analyses at the Flagship Workshop in July 1996, a hierarchy of CAIV cost levers was proposed. All of these levers are important in CAIV implementation. They are discussed below in rough order of potential benefit for most programs:

- Cost/performance/requirements trades. This is the essence of CAIV and will be discussed in detail in following sections.

- Acquisition strategy. Competition is the greatest lever to ensure that CAIV objectives are met that the government has in the early stages of a program. Because of this, competition should be maintained as long as economically practical.

- Concurrent engineering/IPPD. To meet an aggressive cost target, it is critical that all functional planning be integrated and that team members cooperate to resolve difficulties early.

- Contractor enterprise re-engineering. The lean enterprise philosophy encourages industry to concentrate on core capabilities and to develop long-term relationships with key suppliers for non-core activities. It also requires that core activities be conducted with maximum efficiency.

- Commercial specifications, practices, and components. Acquisition reform has enabled use of commercial specifications and practices in many areas. The use of commercial components, where technically feasible, is an important cost reduction tool for many programs.

DoD is striving for cost savings from these "cost levers," which will enable 50 percent and greater reductions in cost from the old way of doing business. The Joint Direct Attack Munition (JDAM) program is a frequently cited example of a program, which is achieving this magnitude of reduction from the broad impact of the new way of doing business.

Figures 14-2 is a straight-forward schematic of the CAIV process, displaying the essentials of what would otherwise call for a complex "wiring" diagram of affordability analysis, cost analysis and engineering, and cost management.

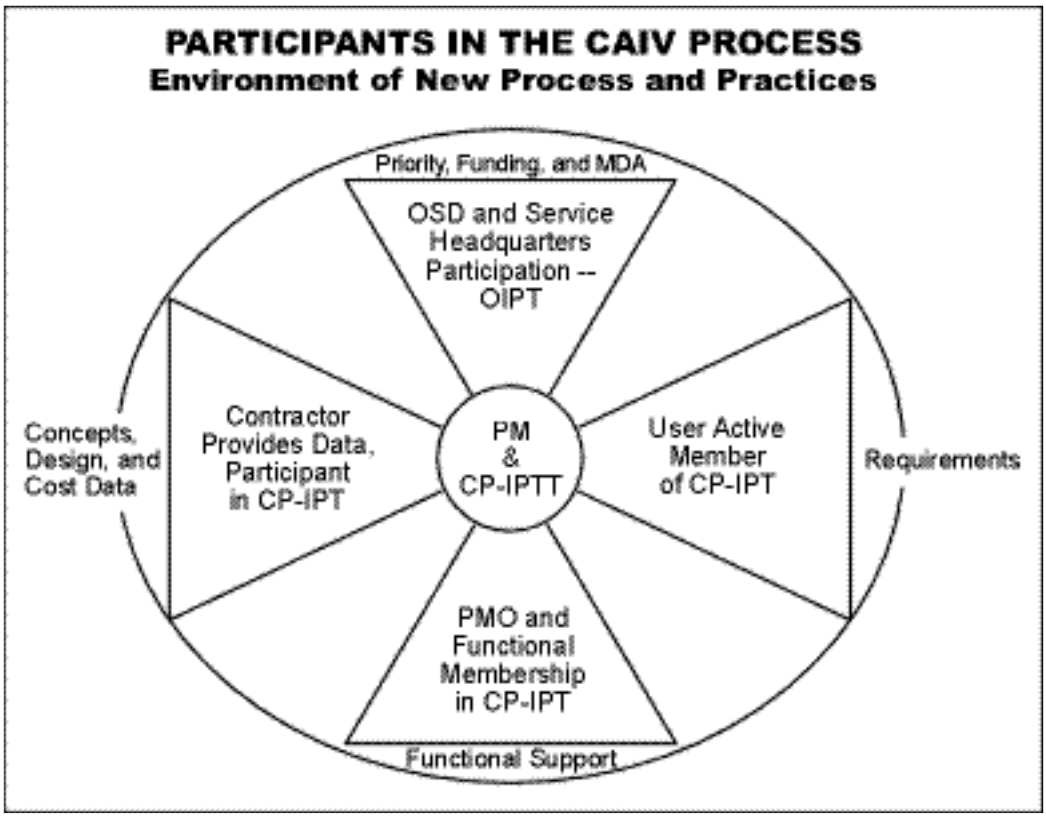


**Figure 14-2: Participants in the CAIV Process**

### 14.2.2 Trade Space

The preceding has consistently addressed the tradeoff process as cost/performance and requirements as a way of emphasizing the role of the user and the importance of the transition from the requirements process to contracting for system performance goals. This emphasizes the different nature of requirements as the system changes. To enhance the effectiveness of CAIV, programs should minimize the number of system performance parameters stated in the Operational Requirements Document (ORD) at Milestone (MS) I. This allows for the development of performance objectives that are achievable and affordable based on actual development and additional analysis during PDRR. If the minimum number of parameters is used consistently to meet the users real needs, greater leeway will be provided for future tradeoffs. The system performance parameters called out in the ORD are designated key performance parameters and are not tradable below a threshold value. For these key performance parameters the trade space exists between the threshold value and objective value with both values stated in the ORD and in the Acquisition Program Baseline (APB). These values are refined by MS II and become part of the system design specification.

For technical performance parameters, the CAIV threshold and objective values should be the same as those in the APB. For CAIV cost threshold and objective values, potential problems may exist because they are equivalent to the APB values. The program budget cannot exceed the APB cost threshold and the cost threshold is specified as 10 percent above the objective value [per 5000.2R, part 3.2.1 and 3.2.2.2]. This may provide little cost room to solve technical performance parameter breaches.

14.2.2.1 Performance. To some extent previous attempts at cost/performance trades have been the victims of inflexible requirements from the user or over-specified requirements by the acquirer. Performance goals have frequently been driven by available technology because the contractor and Program Management Office (PMO) are striving for "the last ounce of performance." The threshold and objective values for key performance parameters should be developed initially as the user translates the broadly stated mission need from the mission area analysis into a system description for the ORD. An analysis of alternative system concepts should be focused on determining the appropriate technical performance trades prior to the initial ORD and APB at MS I. These parameters are stated in the initial ORD and APB and updated at each milestone. For effective contracting, performance must be stated as overall system performance goals, including logistics performance goals. Performance must not be detail specific, quantified, or stated in "how to do it" parameters. In all cases, the user and acquirer must be willing to accept lesser performance to maintain or control cost within the trade space. Changing the culture regarding lesser but acceptable performance is critical to successful implementation of CAIV. Thus, the user must be an integral player throughout the process as the cost-performance/schedule/requirements tradeoffs are made in each phase of the life cycle.

14.2.2.2 Early Cost Estimates. Clearly the tradeoff process is more effective if it can be accomplished earlier in the design process. A large percentage of the cost is determined

by a small percentage of the design decisions. These critical cost-driving design decisions normally occur very early in the concept selection and design process. Because of this, greater success is expected when implementing CAIV for programs in the Concept Exploration or Program Definition and Risk Reduction phases. There are significant problems estimating production and Operating and Support (O&S) costs this early, but these estimates can be updated and improved over the life cycle. Improvement of these estimates will have the greatest program impact if competition continues.

### 14.2.3 Design-To-Cost

How is CAIV different from Design-to-Cost (DTC)? This question is frequently asked in discussions on CAIV. CAIV embodies more than the tradeoff process that is DTC, and there are key conceptual differences. Under CAIV the user is an active participant in the tradeoff process throughout the life cycle. This was not the case with DTC. Another key difference is a more flexible requirement based on threshold mission effectiveness. Earlier planning in the life cycle with an iterative refining of the objectives by the user and acquirer is another difference. In the past DTC has been predominately a contractor's process executed during the system design. In simplest terms, consider DTC as one of the tools for the implementation of the CAIV concept.

### 14.2.4 Process

The DoD initiative on Integrated Product and Process Development (IPPD) and Integrated Product Teams (IPT) is central to the implementation of CAIV. This initiative is expected to be implemented within both the contractor and government organizations. Under the direction of the government Program Manager (PM), a CPIPT will establish the program cost objectives and facilitate the cost-performance-requirements tradeoff process. From the outset, this team's membership will include the user; contractor representation is allowed if determined to be appropriate [see 5000.2R, part 1, section 1.6]. Other members will vary depending on the phase of the life cycle, but membership could include the Service cost center and the OSD Cost Analysis Improvement Group (CAIG) as does the Joint Air-To-Surface Standoff Missile (JASSM) program. A detailed discussion of the membership and roles of the CPIPT is provided in the "Life-Cycle Cost-Performance Concept Paper."[1]

The CAIV process is an iterative one focused around the PM and CPIPT. The PM and CPIPT work with the overarching-IPT representing the PEO, Service headquarters, and OSD to determine funding, receive programmatic direction, and provide program status. The PM and CPIPT must have a strong working relationship with the user community in establishing cost-effective requirements and determining priority. The PM and CPIPT have a number of supporting acquisition organizations ranging from functional support organizations within the component command to Service cost centers providing cost estimating and analysis. Design and cost analysis by the contractors provide the CPIPT with the information necessary to analyze cost/performance tradeoffs. This circle of re-

[1] Attachment to Under Secretary of Defense memo of 19 July 1995, Subject: Policy on Cost-Performance Trade-Offs.

lationships around the PM and CPIPT enable a sequence of activities necessary to accomplish CAIV. These activities include the development of aggressive and affordable cost goals, implementation of incentives to encourage the accomplishment of these goals, and measurement of specific CAIV performance through tracking of metrics. Metrics can include life-cycle cost components such as Program Acquisition Unit Cost (PAUC), Average Procurement Unit Cost (APUC), Average Unit Procurement Cost (AUPC), and technical metrics such as Mean Time Between Failures and Mean Time To Repair.

14.2.4.1 Setting Aggressive Cost Targets. Aggressive cost goals are developed considering a number of elements including available resources, costs of comparable systems and components, mission effectiveness studies, technology based trends, and the use of such initiatives as lean manufacturing and commercial business practices. The CPIPT must use these elements to develop initial aggressive cost goals while balancing issues within the following framework:

(1) Using affordability as the key criterion, the Service headquarters divides a fixed budget among competing programs. Here the cost goals are used in developing a budget required for that program, which is compared with the available dollars in the POM years and based on the priority level established by the Service, JROC, and others. This fixed-budget, which is based on the priority of the program, is the reality of what is available for structuring the program. The current budget may be less constraining in the out-years, but it still drives the program acquisition strategy.

(2) Using mission effectiveness as the key criteria, the user and Service headquarters must determine "the most bang for the buck" of the proposed system. Here analytical studies begin with mission area analysis and analysis of alternatives, and they result in a set of requirements in a Mission Need Statement and Operational Requirements Document. This analysis would look at the proposed program in terms of mission effectiveness versus performance requirements and performance requirements versus cost. There are different DoD organizational elements involved in this analysis, depending on the Service: Center for Naval Analyses (Navy), TRADOC (Army), Air Combat Command (Air Force), and OSD Program Analysis and Evaluation (PA&E). These studies provide the necessary tie between mission requirements, performance parameters, and the cost-effectiveness required of the system.

(3) The PMO would normally have access to independent research and contract studies by contractors that provide concepts and cost estimates for achieving the required system performance requirements. These concepts and associated costs may vary widely from one study to the next, but they provide the critical contractor perspective on the range of alternatives and also provide key data to the above-mentioned analysis of alternatives and funding exercises.

Through the CPIPT, the PM must find a set of initial cost goals that provide an affordable budget and still enable the system to meet at least the threshold requirements of the

user. If the cost goals include consideration of the most likely cost of the performance and schedule requirements, a legitimate trade space for cost/performance tradeoffs can exist and the cost targets can have the necessary realism to be effective. If initial realistic cost goals cannot be developed through this trade program within the budget affordability, the program is not viable. The initial cost goals will be refined at each stage of development to ensure a balance between realistic and aggressive. They will be referred to as cost goals by MS I, as cost targets by MS II, and firm cost targets by MS III.

The key cost targets focus on unit production costs and operations and support costs. The AUPC may be defined in several ways. Some programs such as JASSM and AIM-9X have "bumper-to-bumper" warranty cost (although for differing periods) included in AUPC; others have no warranty cost. Further complicating this definition is the need to specify the AUPC of the total planned production and the average value for each production lot. The second area of cost focus is O&S costs, which are even more difficult to predict. Contractually, operations and support costs may best be handled, as several of the Flagship Programs have, by setting aggressive goals for key performance parameters that drive O&S costs, such as Mean Time Between Failure (MTBF) and Mean Time To Repair (MTTR).

14.2.4.2 Implementation of Incentives. The implementation of incentives is a critical part of ensuring the necessary changes. These incentives can be either positive, for achieving targets, or negative, for failure to meet targets. If the contractor is not meeting the program cost targets, an acquisition strategy could be structured to restart competition. An acquisition to provide the optimum level of competition by phase is one of the most effective ways to ensure cost is minimized. Flagship program examples are the JASSM and EELV Programs, which use rolling down-selects with the final development contract competition. These example programs include low-rate initial production and the incentive of continuation in a sole source mode as long as the final cost targets structured during the final competition are not breached.

In many programs the quantity or other factors prevent the ability to have competition in production. In these situations, the use of award or incentive profit can play a major role. The Crusader Program is an example of a program with a sole source contractor in development through procurement. In this case, the award fee is being used significantly to motivate contractor performance. This is in an environment of minimal mil-specs, mil-stds, and Contract Data Requirements Lists (CDRLs). The Space-Based Infrared Systems (SBIRS) Program uses an incentive fee to share the cost savings between government and contractor. An important motivational aspect for all programs is the shared decision role through participation on the CPIPT.

14.2.4.3 Earned Value. In the case of contracts requiring compliance with DoD Cost/Schedule Control Systems Criteria (C/SCSC) or Cost/Schedule Status Report (C/SSR) requirements, Program Managers and their IPTs should review contractor planning baselines within six months after contract award. The government's review

of a contractor's performance measurement baseline is known as an Integrated Baseline Review (IBR). The objectives of the IBR are to:

- ensure that reliable plans and performance measurement baselines are established, which (a) capture the entire technical scope of work, (b) are consistent with contract schedule requirements, and (c) have adequate resources assigned to complete program tasks;

- improve the use of cost/performance data by government and contractor program managers as a management tool; and

- reduce the number of C/SCSC management systems reviews based on insights developed through assessment of the contractor's actual implementation of their management system and processes on the instant contract.

### 14.2.5 Measuring Performance through Tracking of Metrics

There is a necessity for validated cost models to track life-cycle cost during program execution. The government should have access to the contractors' models and methodology. This does not mean the government and contractor have the same models, but they work together to share and validate. The contractor's design-to-cost system must provide a flow-down of the APUC to the engineering design level, with status reporting, corrective actions, and trend analysis. The reporting process must be made a part of the contract statement of work. The Crusader Program found that the models used for trades were inadequate for cost tracking. The AIM-9X Program found that it was extremely valuable to establish a Government/Contractor APUC Working Group early. Another aspect is maintaining an APUC baseline so the APUC can be re-baselined to account for government-directed design changes, quantity changes, and economic price adjustments. Any change in the baseline must be directly traceable so that the cause and magnitude are documented. Please note the prior discussion of integrated baseline reviews (14.2.4.3).

With regard to the operations and support costs tracking process, it has been handled by the Flagship Programs in one of two ways. On those programs where the contractor has provided a warranty as part of the APUC, the government needs to be concerned only with the cost models at the time of warranty negotiation. Where there is no warranty, the system is measured through test and analysis of the technical parameters driving O&S costs, such as MTBF, MTTR, and staffing requirements. Technical performance measurement should be used to track all critical performance parameters including those driving O&S costs.

### 14.2.6 Summary

CAIV is the key strategy in the management of all system acquisitions in the Department of Defense. The ability of the CAIV concept to achieve significant savings will be demonstrated in the Flagship Programs. However, it will take some time before results are available (early 1997 and beyond). In the meantime, all major defense acquisition programs

in the first two phases of the life cycle were charged with implementing this concept and were required to submit a paper on CAIV implementation by July 1, 1996. These programs continue to annually report progress on this concept to their Milestone Decision Authority. This chapter is largely based on reference (g) below.

### 14.2.7 Points Of Contact/References

a. OUSD(A&T), Principal Deputy Director Strategic and Tactical Systems, telephone 703-695-7417.
b. Defense Systems Management College, Faculty Division, telephone 703-805-3683.
c. Program managers referenced in Figure 14-1.
d. *Defense Acquisition Deskbook.*
e. Kausal, B. A., "Controlling Cost – A Historical Perspective," *Program Manager*, November-December 1996, Defense Systems Management College, Fort Belvoir, Virginia.
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g. Rush, Benjamin, "Costs as an Independent Variable: Concepts and Risks," *Acquisition Review Quarterly*, Spring 1997, Defense Systems Management College, Fort Belvoir, Virginia.