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Report to Secretary, Department of Defense; by Richard W. Gutmann, Director, Procurement and Systems Acquisition Div.

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Authority: DOD Directive 5000.1.

The Department of Defense's (DOD's) use of the design-to-cost concept as applied to the following programs was reviewed: A-10-Close Air Support Aircraft (Air Force); AATS--Advanced Medium Short Takeoff and Landing Transport (Air Force); UTTAS--Utility Tactical Transport Aircraft System (Army); CH-47 MOD--Modernization of Chinook Medium Lift Helicopter Fleet (Army); and FFG-7--Guided Missile Frigate (Navy). Although these programs lent themselves to successful application of the concept, the concept as defined by DOD was not closely followed. Departures in implementing the concept included: not establishing design-to-cost targets during concept formulation when the greatest flexibility existed, overemphasis on controlling the more immediate acquisition costs rather than life cycle costs, and failure to develop the cost data base needed to establish cost-performance estimating relationships. Special study teams should be organized to assess implementation of the concept in existing programs and to review plans for its implementation in new programs. The assessments and reviews should focus attention on discrepancies between the concept and its implementation, operate as a corporate memory of lessons learned, and provide program managers with the experience needed to better adapt design-to-cost to their individual programs. (Author/HTW)

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UNITED STATES GENERAL ACCOUNTING OFFICE

WASHINGTON, D.C. 20548

PROCUREMENT AND SYSTEMS
ACQUISITION DIVISION

B-163058

March 20, 1978

The Honorable
The Secretary of Defense

Dear Mr. Secretary:

We reviewed the Department of Defense's use of the design-to-cost concept as applied to the following programs:

- A-10; Close Air Support Aircraft (Air Force).
- ANST; Advanced Medium Short Takeoff and Landing Transport (Air Force).
- UTTAS; Utility Tactical Transport Aircraft System (Army).
- CH-47 MCD; Modernization of Chinook Medium Lift Helicopter Fleet (Army).
- FFG-7; Guided Missile Frigate (Navy).

The concept has been applied to these programs for several years. Each program had reasonably firm design-to-cost goals before contracting, large projected production runs, early consideration of life cycle costs, medium technological risks in four programs, and some contractor competition in three programs. These conditions, in our opinion, made the programs good candidates for successful application of the design-to-cost concept.

Generally, we found that the design-to-cost concept, as defined in Department of Defense Directive 5000.1, July 13, 1971, was not closely followed. The departures in implementing the concept included:

- Design-to-cost targets (affordability limits) were not established during concept formulation, when the greatest flexibility existed to maximize total performance for the dollars available.

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--Overemphasis on controlling the more immediate and visible acquisition costs rather than the more substantial life cycle costs.

--Failure to develop the cost data base needed to establish cost-performance estimating relationships relevant to design-to-cost objectives, goals, and decisions.

Establishment of goals

Of the five programs reviewed, only the Navy's FFG-7 program established design-to-cost goals before conceptual design. The goals were based on early feasibility studies that determined relationships between size, cost, and number of escort ships that would maximize force effectiveness within anticipated funding constraints. The FFG-7 project manager attributed substantial savings on each follow-on ship to conceptual design decisions required to stay within the design-to-cost constraints.

In the other four programs, design-to-cost goals were not established until after the basic or minimum performance requirements had been defined; that is, after completion of the conceptual phase of the system's acquisition cycle. Design-to-cost goals for the Army's UTTAS and CH-47 MOD and the Air Force's A-10 programs were based on estimates of system costs, determined by past experience. In the two Army programs, the estimates were reduced about 4 and 11 percent to make them an obtainable challenge. In the Air Force's A-10 program, the goal of \$1.5 million was an average of a number of parametric estimates based on conceptual design characteristics ranging from \$1.2 to \$1.7 million. The AMST program established a goal of \$5 million for the 300th aircraft; we were unable to determine the basis for this goal.

Emphasis on unit production costs

Although the contractors considered operating and support cost elements that did not increase production costs, they had little motivation to trade off lower predicted life cycle costs for known higher unit production costs. In addition, credible life cycle cost estimates were not available for assessing trade-offs between tightly constrained unit production costs and downstream operation and support costs. In our recent letter to you concerning life cycle costing (PSAD 78-74, March 2, 1978), we discussed

in greater depth the necessity of considering life cycle costs during the acquisition process.

The Air Force's A-10 program introduced a 10-year life cycle cost requirement, but the emphasis was on meeting the stringent unit production cost goal for continued program support. This did not provide the latitude needed to trade off added development and production costs for reduced life cycle costs until after the design was considered frozen. In the Air Force's AMST program, the production cost goal and limitation on the Government's obligations during prototype validation discouraged trade-offs to lower life cycle costs that may have increased prototype development costs.

In the Army's UTTAS program, contractual design-to-cost goals and incentives were placed on average airframe production cost, which discouraged trading off lower predicted life cycle costs for known higher airframe costs. As a result, both contractors made and implemented hundreds of cost-performance trade studies to reduce airframe production costs.

In the Army's CH-47 MOD program the contractor's cost model did not include the impact of trade-offs in achieving design-to-cost unit production goals on operation and support costs. The Army stated that it had studies which claimed to reduce investment and operating costs for the CH-47 MOD, but design changes would require additional research and development funds that were not then available.

Although the Navy did not want to sacrifice disproportionate long-term life cycle costs because of pressure to meet its design constraints in the FFG-7 program, credible life cycle cost estimates were not available for assessing trade-offs between ship construction costs and downstream operation and support costs. Consequently, life cycle cost considerations were secondary to construction costs, and major trade-offs in shipboard manning and growth margins were made to reduce ship construction costs, without fully understanding their impact on life cycle costs.

Cost data base

We did not make a detailed analysis of the cost data base or estimating procedures. However, available information indicated that useful cost data and estimating procedures, especially computer models, were in their early development phases. What was available required major adjustments and modifications to be credible and useful to designers, production engineers, and logistics support specialists.

Our review of the four Air Force and Army programs indicated that the Air Force was ahead of the Army in developing cost estimating data and procedures and models to support and monitor contractor design-to-cost applications. For example, the Army was not able to directly assess trade-offs between cost and specific performance characteristics, such as speed, rate of climb, and endurance, during the conceptual phase of the UTTAS program. Also, the Army relied on its contractors to develop the cost data base and methodology required to manage design-to-cost efforts during system validation and development. This reliance produced mixed results. Army documents show that one UTTAS contractor's design-to-cost procedures, which included little management visibility on the status of detailed component level costs and an inability to track design-to-cost estimates to baseline production estimates, were also in the CH-47 MOD program.

The Navy, which designs its own ships, imposed constraints on full load displacement and shipboard accommodations as a method of controlling design of the FFG-7 and staying within the design-to-cost goal. Engineering constraints were used because the Navy could not provide timely cost estimates relevant to the decisions being made by its design engineers and logistics support planners. In addition, the Navy did not require the lead ship contractor to develop design-to-cost procedures, track costs to a design-to-cost goal, or provide the information needed to factually assess progress to the goal.

Although the Navy estimated \$8.7 to \$12.2 million in design-to-cost savings resulting primarily from its engineering constraints, its estimates for the fiscal year 1979 buy of eight follow-on ships show a cost growth of about 86 percent (\$39 million per ship) in constant 1973 dollars, despite the fact that there are only marginal increases over displacement weight and shipboard accommodations.

COST CONTROL

Traditionally, pressures have been toward increased performance during development with little consideration of cost. Regardless of the differences between the concept and its implementation, design-to-cost goals have discouraged demands for additional performance that would have increased production costs. In fact, the design-to-cost goals and constraints, which by necessity were based on preliminary information of cost-performance relationships, may have become more important than technical requirements.

during design and development. In both the A-10 and FFG-7 programs, the goals and constraints were rigorously adhered to in design decisions that traded off performance features. The danger was that the goals and constraints may have caused designers to ignore or discard features which were cost-effective, needed, and affordable.

In the FFG-7 program for example, the ship was designed with small space, weight, and stability margins. Although this reduced the cost of the ship, some necessary future improvements might be impractical if compensating equipment removals cannot be made. This, in turn, could affect the capability of the ship to perform its mission against a changing threat. It was still too early to fully evaluate the design-to-cost efforts, since no system had been produced in sufficient numbers or had sufficient field experience to demonstrate its cost-performance relationships.

RECENT GUIDANCE

Four of the five programs we reviewed were initiated before the Department of Defense's current directives, guidelines, and instructions were developed. These documents provided information and guidance for implementing the concept, based on accumulated experience. Nevertheless, the discrepancies discussed above appear to be present in many of the more recent programs.

Departmental guidance points out the need to establish cost objectives or goals during the conceptual phase, because about 70 percent of a system's life cycle cost is determined by decisions made at that time. At the time of our review, however, the Office of the Director of Defense Research and Engineering 1/ reported that 21 of 62 major acquisition programs were in system validation without established design-to-cost goals and five programs were in full-scale development without established goals. Except for the five programs we have discussed, we do not know if any of the remaining 36 programs had design-to-cost objectives established before basic or minimum performance requirements were determined.

Our review of the Army's recent CH-47 MOD program shows no discernable improvement over its earlier application of

1/Recently changed to the Office of Under Secretary of Defense for Research and Engineering.

the design-to-cost concept in the USFAS program. We also found no noticeable improvement in the Navy's ability to estimate and directly control costs during ship acquisition than existed during the design of the FFG-7. An adequate cost data base for cost estimating and control and contractual implementation of the concept is needed for design-to-cost in ship acquisitions to be more than a method for inducing greater cost consciousness through the use of displacement, accommodations, or similar broad engineering constraints. Also, the rigid application of broad engineering constraints will probably be limited to those few cases, such as the FFG-7, where the number of ships to be built is large and where limited mission requirements will allow performance to be traded off to stay within the engineering constraints.

CONCLUSIONS AND RECOMMENDATIONS

We believe the Department's 6 years of experience in applying the concept shows the need for special advisory teams to assist program managers in adapting design-to-cost principles and guidelines to the dynamics of their individual programs. These teams would also help focus service-wide attention on problems outside the authority and responsibilities of the individual program managers; that is, developing affordability limits, minimum performance requirements, and a cost data base relevant to design-to-cost objectives, goals, and decisions. We believe attention should be given to developing affordability limits and design-to-cost targets during concept formulation when the greatest flexibility exists to maximize total performance for the dollars available.

We are recommending that you organize special study teams to assess implementation of the design-to-cost concept in existing programs and to review plans for its implementation in new programs. The assessments and reviews should (1) focus service-wide attention on discrepancies between the concept and its implementation, (2) operate as a corporate memory of lessons learned, and (3) provide program managers with the experience needed to better adapt design-to-cost to their individual programs.

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As you know, Section 236 of the Legislative Reorganization Act of 1970 requires the head of a Federal agency to submit a written statement on actions taken on our

recommendations to the Senate Committee on Governmental Affairs and the House Committee on Government Operations not later than 60 days after the date of the report and to the House and Senate Committees on Appropriations with the agency's first request for appropriations made more than 60 days after the date of the report. We would appreciate receiving a copy of your statement when it is provided to the congressional committees.

Copies of this letter are being sent to the Chairmen of the House and Senate Armed Services and Appropriations Committees; House Committee on Government Operations; Senate Committee on Governmental Affairs; and to the Secretaries of the Army, Navy, and Air Force.

Sincerely yours,



P. W. Cutmann
Director