AN ANALYSIS OF MULTI-YEAR PROCUREMENT COST ESTIMATING METHODS AT THE AERONAUTICAL SYSTEMS DIVISION

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DEPARTMENT OF THE AIR FORCE
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Wright-Patterson Air Force Base, Ohio

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Multi-year procurement (MYP) has been receiving increased emphasis generated by high levels in DOD. Although the benefits resulting from MYP have been identified from many different sources, the cost savings attributed to those benefits are often difficult to identify. Cost estimates of those savings often lack credibility. This research effort examined cost estimating methods for five different MYP programs at the Aeronautical Systems Division (ASD). Reasons for cost savings are identified and those savings are quantified for each program. Similarities and differences in Program Office savings attributable to different areas (key variables) are determined and general areas of cost savings to be considered in estimating MYP are identified.

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A Thesis

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By

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CHAPTER I

GENERAL ISSUE AND BACKGROUND

The vast majority of current Air Force contracts are negotiated and their costs are correspondingly estimated on an annual basis. Government program offices are constantly negotiating annual contracts throughout the lives of their programs. As a result Defense contractors are continuously anticipating whether or not they will have a major contract next year. A mutli-year contract commits both the contractor and the government to a procurement effort of not just one year, but multiple years, normally three or five (6:1). Though government program offices are reluctant to commit to multi-year buys because of inherent design changes, possible obsolescence, and other reasons, the advantages to both the contractor and the government program offices resulting from multi-year contracts can be tremendous (6:3). Estimates of these savings range from 10 to 30 percent of the contract cost, as a result of long term capital investment, labor continuity, and other reasons (25:5). Confidence in these estimates is not strong, however.

Single-Year (Annual) Procurement

Annual procurement is "the way we are forced to do business today" in the DOD acquisition environment (24:40). No attempt to negotiate a contract in advance of the actual appropriations act is made because, by law, "no officer or employee of the U.S. will make or authorize an expenditure from or create or authorize an obligation under any appropriation or fund in excess of the amount available therein (9:40)." Since these appropriations are set annually by Congress, the law and official policy coupled with existing fiscal constraints effectively limit systems acquisition to annual procurement.

Multi-Year Procurement

The Defense Acquisition Regulation (DAR) defines multi-year contracting as "a method of acquiring for DOD planned requirements for up to a five-year period, without having total funds available at time of award (9:42)." A multi-year contract under present regulations allows for the situation where only the first year of the contract is initially funded and

> ... the contractor is protected against loss resulting from cancellation by contract provisions allowing for reimbursement of unrecovered non-recurring costs included in prices for cancelled items (9:42).

Prior to 1982, the cancellation ceiling on multi-year contracts was $5 million, unless increased by congressional approval.

Cancellation Ceiling

In 1972 the Navy cancelled a number of major shipbuilding multi-year contracts, effectively causing the contractor to shut down the production line prior to completion of any end items. As a result of previous contract provisions, the Department of Defense (DOD) was obligated to compensate the contractor for the value of the recurring and non-recurring costs he incurred, $109.7 million in all (7:1). Based on this result, Congress lowered the cancellation ceiling (the maximum dollar amount a contractor may be compensated by the government) to $5 million and eliminated any provision for compensation of recurring costs incurred (34:34-35). The resulting risk to potential contractors led to a drastic decrease in the number of multi-year contracts accepted. This marked the end of a previously extensive use of multi-year contract awards throughout DOD.

The DOD Authorizations Act of 1982 recently raised the cancellation ceiling on multi-year contracts to $100 million and permitted compensation of recurring as well as non-recurring costs (35:165). In addition, Congress has taken an interest in promoting the awarding of multi-year contracts where a

potentially large cost savings can be anticipated (25:2).

Areas of Cost Savings

Numerous DOD and civilian agencies have cited cost savings resulting from multi-year procurement. In his 1980 initiatives, Under-Secretary of Defense Frank Carlucci listed "recommendations calling for increased use of multi-year contracting" and cited cost savings of ten to twenty percent under multi-year procedures (36:1). Shortly after the Carlucci initiatives were issued, the Defense Science Board, in its 1980 Summer Study, concluded that "the savings potential for multi-year contracting is estimated to be from ten to fifteen percent (34:1621)." More recently, the General Accounting Office (GAO) evaluated nine programs offered as candidates for multi-year procurement for fiscal year 1983 and estimated the average cost of the multi-year contracts to be 9.2 percent lower than the average cost of the annual contracts (25:8).

Government estimators are not the only group that feels that multi-year contracts will result in cost savings. Hughes Aircraft Company, a major defense contractor, projects savings of from 20 percent to 30 percent resulting from awarding a multi-year contract compared to annual contracts (26). Another major defense contractor, the Northrup Company, cited savings to DOD of $10.6 million on the procurement

of power management systems by opting for a MYP strategy (30). Aerojet Corporation, a third major defense contractor, has estimated that a MYP strategy will save the DOD $33.9 million in the procurement of the GAU-8/A gun system (3:7).

Both contractor and government estimates conclude that cost savings will result from the awarding of a MYP contract rather than annual contracts. Savings in the areas of economic order quantity (EOQ) buys, capital investment, labor continuity, inflation avoidance, taxes, and administrative costs may all lead to the aggregate savings listed earlier.

EOQ Savings

Perhaps the greatest single reason for the substantial cost savings realized through multi-year procurement is that materials, parts, and components for end items to be produced over a number of years may all be purchased up front. That is, large economic order quantities of materials can be bought early resulting in lower prices. Most of the savings in multi-year procurement arise from first-year contractual obligations on long-lead-time items and economic-order-quantity purchases (10:118). Studies indicate that the savings could be as high as 10 to 20 per cent (10:115). Savings at both the contractor and sub-contractor level may be realized and passed along to the government.

Though the belief that cost savings may be experienced through EOQ purchases has been stated, none of the literature reviewed addresses a methodology to estimate those savings. Contractor prices on large quantities of long-lead items may be very different under annual and multi-year environments, but the variance in those prices has yet to be investigated.

Capital Investment

Investment in capital equipment is another area where cost savings may occur. If a contractor is assured of business for three or more consecutive years, he may want to invest in improving the producibility of those goods responsible for bringing him the business. Until the passage of the 1982 DOD Authorization Act, however, contractors were wary of committing large amounts of their money to capital investments lest the government cancel its contract, as was mentioned earlier. Previously, in that case, the contractor could receive no more than $5 million to cover the non-recurring costs he incurred; the recurring costs were lost forever. The Army Procurement Research Office stated that "the $5 million cancellation ceiling effectively limits the application of multi-year as an incentive for the large investments required for most system acquisitions (37:10)." The GAO states that "few contractors would be willing to incur such (large)

investment expenditures without a Government commitment to fund and pay such costs as they occur (23:9)."

Current methods of estimating cost savings due to MYP resulting from capital investment are seriously lacking in that they do not address the potential magnitude of the cancellation ceiling (36:24). These methods do not consider the potentially enormous costs to compensate the contractor for recurring and nonrecurring costs if the government cancels a contract; they assume away the possibility of a cancellation. In fact, the entire area of long-term cost savings resulting from capital investment is as yet unexplored.

> Capital investment is currently being treated as a desired end rather than a means to an end (that end being long-term savings). When capital investment strategies have been implemented, they were always a last resort effort to solve an immediate problem. They may not have been used as part of any comprehensive plan. It is therefore recommended that a clear policy on incentivizing capital investment be articulated and promulgated to the field (37:14).

Labor Continuity

Most documents describing the benefits of multi-year procurement cite labor continuity as a major cost saver (6:3). Training labor for unique government contract requirements can be very costly. Therefore, once workers are adept, it is to a contractor's advantage to realize ever-increasing productivity from those workers as long as possible. The

retention of skilled workers leads to savings that can be passed along to the government through the awarding of multi-year contracts. Cost savings realized through hiring, firing, or retraining employees in anticipation of a major production effort are a function of management's philosophy. A labor-intensive firm may realize greater savings that it could pass along to DOD than a more automated company may realize. Estimating methodologies isolating the effects of labor continuity on MYP cost savings were not found in the literature reviewed.

Inflation Avoidance

Early purchases of materials made before the prices of those materials go up lead to cost savings. The degree of cost savings to be incurred depends on projections of inflation rates in future years and the holding costs associated with keeping those materials in storage until they are needed. Holding costs are a function of the available storage area a firm has at its disposal and may therefore be determined with a relative amount of certainty. Since a tradeoff exists between holding costs and inflation avoidance, the uncertainty in estimating savings due to MYP resulting from early purchases of materials lies in the area of inflation avoidance. The problem of choosing appropriate inflation indices is addressed in much of the current

literature pertaining to multi-year procurement. OMB A-94 currently prescribes the use of a 10 percent rate. The GAO feels this is too low and cites 13.9 percent as a more accurate estimate of inflation to experience in future military procurements (25:2). Likewise, DOD and each of the services have their own inflation indices, and reasons to use any particular one of these rates can be found. The uncertainty in estimating savings as a result of "beating" inflation is listed as one of the "unresolved issues" discussed at the 8th Annual DOD-FAI Acquisition Research Symposium (8:12).

Tax Savings

Another area of cost savings deals with tax savings and is explained by the GAO:

> Multi-year contracts with contractors using the completed contract method for federal income tax purposes may result in an extended tax payment deferral period as compared with annual contracts which require two or more years to complete to defer the cost and income associated with these contracts to the completion year ... The cost of money associated with this added deferral period could... effect net savings to the government (25:4).

Thus DOD can save a portion of what the contractor saves as a result of the time value of money. Further, the attractiveness of this tax savings, as well as any of the previous savings realizable by the contractor, may result in more contractors wanting a "piece of the pie." "Wider interest on the part of industry would contribute toward strengthening the

industrial base and driving down prices for the government (29:121)." Methodologies to quantify cost savings pertaining to the tax area and the capital investment area were not found in the literature reviewed.

Administrative Savings

Finally, the costs of annually re-negotiating contracts can be reduced with the implementation of multi-year procurement. Much of the responsibility for the annual negotiating effort of major contracts is given to large program offices whose personnel are government employees. The absence of an annual negotiating effort would permit these individuals to better use their time and effort. Again, methods for estimating these savings were not found in the literature reviewed.

Requirements for a Model

Six areas of cost savings as a result of MYP have been identified: EOQ buys, capital investment, labor continuity, inflation avoidance, tax savings, and reduced administrative efforts. The literature reviewed states that savings can be realized in each of these areas when a MYP contract is awarded. Methodologies to estimate the aggregate of these savings, that is, a single lump sum cost savings, have been developed and are mentioned in the next section. Unfortunately, these aggregate methodologies require the contractor's

annual and multi-year bid prices. Usually this information is not available from the contractor; even if it is, its validity is questionable and government agencies do not have the means to verify it. Most of the government savings estimates done today are "primarily based on budgetary data, judgemental estimates and preliminary quotes or other undocumented data from the potential prime contractor or subcontractors (25:8)." More often than not, judgement becomes the primary tool used by the estimator. The DOD's Policy Memorandum on Multi-year Procurement concerning estimates of cost savings states that (20:57):

> There should be a reasonable assurance that cost estimates for both contract and savings are realistic. Estimates should be based on prior cost performance history for the same or similar items, or on proven cost-estimating techniques ...

Existing Models

Two reasonably comprehensive methodologies for estimating cost savings due to MYP contracts are documented in the current literature. Booz-Allen and Hamilton, Inc. prepared an Analysis of Cancellation and Termination Aspects of Multi-year Procurements for the Defense Management College in December of 1982. Five areas of cost savings were identified, all leading to some manipulation of learning (cost improvement) curves over the life of a candidate program. The identified areas of EOQ buys, labor continuity, capital investment,

reduced administrative effort, and inflation avoidance were each considered together with an assessment of the contractor's labor-material mix. This analysis provides a reasonably comprehensive estimate of cost savings. Breaks in learning curves as well as changes in curve slopes occurred as a result of each separate area of cost savings. The authors were quick to note, however, that the determinations of inflation, the discount rate applied to present value analysis, and the labor-material mix would all have to be measured very carefully for their model to be reliable (7:17-26). Booz-Allen and Hamilton have taken perhaps the most thorough and realistic approach to estimating cost savings resulting from multi-year procurements.

Kathleen P. Utgoff and Dick Thaler take a purely economic approach to assessing cost savings. Within both a monopolistic and imperfectly competitive environment, fixed and variable costs and the profit motive are the determinants of the firm's most efficient output. The consideration of advanced material buys and funded cancellation ceilings are the primary reasons for cost savings and their effects are illustrated both mathematically and graphically. Tradeoffs between capital investment and cancellation ceilings are considered. The authors address the time value of money and cite it as leading to theoretical cost savings if managed properly (26:7-34). When applied

to the current F-16 multi-year contract, this time value of money area appears to have some validity. From a theoretical point of view, Utgoff and Thaler's efforts yield useful results and a realistic approach to addressing the savings incurred under MYP.

Cost Confidence

DOD's response to the validity of esitmated cost savings of multi-year candidate program contracts was indicative of most responses.

> It is our view that the budgetary nature of the justified data provided in support of projected savings for the proposed FY83 multi-year contract projects are insufficient to estimate the reasonableness of the claimed savings (25:2).

The Marine Corps Operations Analysis Group stated that "DOD has been advertising large savings from multi-year contracts. We show that these savings estimates are based on an invalid comparison of conventional and multi-year contracts (26:30)." The problem is evident; valid, generally accepted methods to estimate cost savings resulting from multi-year procurement contracts are not being widely used.

Problem Statement

A number of differing methodologies for estimating savings resulting from MYP are used throughout DOD. However, very few similarities or difference in these methodologies are documented. The lack of

sound rationale behind the development of these methodologies has led to their lack of validity (8:25). A thorough documentation of these methodologies, requiring rationales for cost savings, has not been accomplished.

Objective

Many different methodologies for estimating cost savings resulting from MYP exist at the Aeronautical Systems Division (ASD). Since Secretary Carlucci's initiatives demanded that every major acquisition effort be considered for MYP (35:3), numerous System Program Offices (SPOs) at ASD are estimating potential savings resulting from MYP. The objective of this research is to thoroughly document various cost estimating techniques used to determine cost savings resulting from MYP. This effort includes the identification of key variables and the similarities and differences between different techniques.

Scope

Data will be collected from ASD SPOs. The relatively large size of the ASD Cost Shop (ACC) as well as the large number of major procurement programs make ASD an ideal place to collect data on MYP cost savings.

CHAPTER II

METHODOLOGY

Annual and MYP Estimates

To estimate a cost savings resulting from MYP, the MYP cost estimate must be compared to an annual cost estimate. While every SPO at ASD estimates the costs of the currently directed program, only those that have estimated both an annual and multi-year approach will be useful for gathering data for this research. Cost estimates may be documented using any type of cost breakout available. Usually costs are reflected by Work Breakdown Structure (WBS) element, where WBS elements are defined as work "packages" that must be accomplished to fulfill the contract terms (8:40). Each WBS element has an associated cost in both annual and multi-year estimates, and the aggregate of all WBS element costs will reflect the total cost estimate. For both annual and multi-year estimates to be effectively compared, a standard WBS should be used. However, seldom if ever do SPOs have detailed WBS breakouts of both the annual and multi-year cost estimates.

The only documents directly comparing annual estimates to multi-year estimates are the initial contractor proposals and the MYP Justification Packages. AF Forms 1537 list estimated costs of the currently

directed program, but usually not at a detailed level. The SPO Blue Book estimate is a "grass roots" effort that may or may not consider currently directed policies. The MYP Justification Package only considers those portions of the program estimate that would be affected by a multi-year environment (9:4). Therefore, comparisons at a detailed WBS level are difficult.

MYP Justification Packages must be submitted to HQ USAF when programs receive consideration as MYP candidates. Per Secretary Carlucci's 1981 Initiatives, this package contains a by-year comparison of the annual vs multi-year cost estimates, a yearly cost savings resulting from a multi-year vs annual buy, sources of savings (key variables), and the reasons why those key variables resulted in savings (9:4).

While both the MYP Justification Package and the contractor proposals submitted in support of a multi-year buy cite general areas of cost savings, the reasons why these key variables lead to cost savings are often not explained. Since contractor plants are set up differently, the manufacturing key variable will result in different magnitudes of cost savings for different programs. The extent of the subcontracting effort determines the degree to which the Vendor Procurement key variable will lead to cost savings. Program characteristics will affect the magnitude of savings resulting from all key variables, and those

characteristics differ for all programs. The only key variable whose resultant savings can be tracked consistently would be inflation avoidance, since inflation indices are available and funding profiles are presented in the MYP Justification Package (9:42).

Estimating Techniques

The particular estimating technique used to derive both the annual and multi-year estimates can determine the impact of key decision variables on WBS element costs. Depending on program characteristics and the cost estimator's capabilities, some techniques may not be as applicable as others in arriving at an accurate cost estimate. The following four techniques illustrate different methods to estimate costs (31).

1. Cost-to-cost Factor Estimating - Estimating the cost of a new item by establishing a ratio between known cost elements or prior systems. For example, a two-engine trainer jet may be estimated to cost 1-1/3 times as much as a currently used single engine trainer. This method is usually employed when time is a major constraint to the estimator.

2. Parametric Cost Estimating - Estimating the cost of a new item by correlating design parameters to historical costs through a regression analysis that describes the relationship between cost and those parameters. Specific weights, dimensions, and quantities are needed for subcomponents of the total item.

These values are frequently fed into a computer and the output contains the costs of each of those sub-components. Estimators use this method when time is not a constraint and physical parameters of system sub-components are known. Parametric estimates are more detailed than cost-to-cost factor estimates.

3. Analogous Estimating - Estimating the cost of a new item based on the known cost of a similar item in a prior system. Adjustments are made to known costs to account for differences in relative complexities of the performance, design, and operational characteristics of the compared items. An estimator using this technique may realize that a new missile seeker is 1/2 the size of an analogous seeker, has ten more ICs (integrated circuits), and has a range fifteen miles greater than the analogous seeker. He thus raises the estimate of the cost of the new seeker above that of the analogous seeker accordingly. A thorough understanding of the system to be estimated and analogous systems is necessary to apply analogous estimating techniques.

4. Engineering Cost Estimating - Estimating the cost of a new item by defining the effort to be accomplished, the schedule it is to be accomplished against, and the materials and processes to be used. This technique considers unique characteristics of the program such as schedule and manufacturing environment, factors that none of the other techniques consider.

An estimator using the engineering cost estimating technique must be familiar with the SPO characteristics as well as the system he is estimating.

ASD SPOs may use a combination of these techniques or other methods. Whichever technique is used to derive the annual and multi-year estimates, the degree to which key decision variables lead to reductions in WBS element costs may be influenced by the type of estimating technique used.

Gathering and Analyzing Data

Cost estimators in the ACC staff office and various SPOs will provide the data required for this research effort. The results of interviews with these individuals and any supporting documents that they may have available, such as MYP Justification Packages and Blue Books, will constitute the data.

Interviews shall be structured so as to allow the estimator to comment on some area of MYP cost estimating that the research may not have considered. In this way, each cost estimator will be free to cite any key variables and reasons for their savings without having been biased by pointed questions developed for this research effort. Although the interview results will be unbiased, their formats will also differ. This may lead to difficulties in comparing and contrasting results in Chapter IV.

Three basic questions will be asked of each cost estimator interviewed. These questions will not be satisfied with yes/no answers. Rather, the estimator will be given time to comment on each question at length. The questions are:

1. Do you feel that cost savings can occur as a result of awarding a multi-year vs annual contract?

2. Is the multi-year estimate lower than the comparable annual estimate? If so, why?

3. What data do you base the projected savings on?

Upon collection of all interview results and supporting documents, a direct comparison of WBS element costs between the annual and multi-year estimate will be made. Differences between those costs will be noted. The major portion of this research will then be to determine the specific reasons why those cost differences exist. This process will identify a set of key variables for each program. A thorough documentation of these cost differences and key variables along with a comparison of all the key variables used by all of the SPOs to identify similarities and differences will be accomplished in this research effort.

CHAPTER III

RESEARCH FINDINGS

Observations on Estimating MYP Cost Savings at ASD

Staff cost analysts as well as estimators from five different programs were able to share some experience in comparing annual and multi-year estimates. Those five programs were the F-16 program, the B-1B program, the KC-10 program, the KC-135 re-engineering program, and the 30mm ammunition program. Experience levels of the estimators, different program characteristics, and the phase the program was in all led to the non-standardized interview results contained in this chapter.

Although the MYP Justification Packages are standardized to include the four sections mentioned earlier, no two programs could be readily compared. For example, the prime contractor for the F-16 had prior knowledge of, or at least substantial reasons to anticipate, the awarding of a multi-year contract by virtue of the fact that the multi-national F-16 program had initial long-term commitments to foreign countries (17). Both the KC-135 re-engineering and KC-10 programs are military buy-ins to commercial ventures that have been in production for some time. Therefore, up-front cost savings resulting from rapid manufacturing buildup and engineering streamlining can

not be realized (27). While EOQ savings will result in most multi-year programs, commercial engines for the KC-135 have been procured for some time and their costs will not decrease with increased quantities as they did earlier in the production of those commercial engines (32). The 30mm ammunition program was designated a multi-year program prior to the development of Carlucci's Initiatives (24). Therefore, no MYP Justification Package or cost estimates of the potential savings realizable had to be developed. Each program estimated multi-year cost savings under different procurement environments.

Comparative cost estimates were requested of many SPOs, but very few had assessed the cost impacts of MYP to any extent. Frequently estimators used references to contracting and procurement office efforts to assess MYP cost savings. These references were made because, prior to 1981 and the development of Carlucci's Initiatives, the emphasis on MYP was minimal; MYP Justification Packages were not required. Savings were not estimated, they were assumed to be present (13).

A great deal of reliance is placed on a contractor's MYP proposal in the early stages of a program to develop the initial estimate. Prior to that, the estimator and the contractor sit down informally and agree on realistic costs to present as initial estimates.

A good deal of emphasis is placed on the cost savings as a percentage of total contract cost. That value must be high enough to justify the consideration of a multi-year contract award.

Historical data is used to apply a percentage savings to the bottom-line value of a contract rather than applying key variables to many functional areas, summing the savings, and computing that percentage savings of the overall contract price.

Not a single estimator felt that the estimating technique used (parameteric, analogous, etc.) had a bearing on the magnitude of the cost savings. Key variables were the reasons for cost savings, not the method of estimating used.

To gain a firmer position in the defense industrial base, contractors may commit to a low price for a MYP contract realizing that although they may be selling below cost in the early years, the cost benefits of MYP will reduce their costs enough so that they realize some form of profit. This profit, however, is not their main concern; they want to get a foothold in the market, so they are willing to take a loss initially (13).

Interview Findings

Cost Estimating Staff Office

Estimators in the Cost Estimating (ACC) Staff Office do not develop program office cost estimates.

While they may review SPO estimates, ACC workers are not responsible for developing MYP estimating methodologies (22). They therefore have an understanding of the fact that MYP cost savings may occur, but they can not identify the potential magnitude of those savings.

ACC staffers recognize a number of characteristics of MYP. They felt that MYP would "stabilize" a program, meaning that once the Air Force had committed itself to a long-term contract, fluctuations in design configuration, approved quantities, and approved funding levels would be minimized (22).

Contractor inputs are a major portion of the estimated cost savings resulting from the awarding of a multi-year contract, according to ACC staff members (22). In fact, prior to the development of a SPO multi-year estimate, the contractor's multi-year estimate may be referred to as a highly reliable and accurate document. MYP could be detrimental, according to ACC staffers, in that it may greatly restrict the technological expansion over the entire industrial base (13). By awarding a long-term contract to only one contractor, the Air Force allows that contractor the freedom to vigorously pursue the technology required to fulfill the contract, but it denies other contractors the incentive to build that same technology. This inequity could hurt competition in the long run in that the

Air Force would have only one contractor to approach concerning future contracts requiring the given technology level.

The awarding of a multi-year contract could stimulate capital investment and corporate re-structuring with the increased desire for contractors to attain their maximum production efficiency rates early (13). For this reason, production and delivery schedules must be coordinated to attain efficient production rates.

Often contractors may be willing to submit bids and enter a multi-year contract incurring a high initial loss. They may see the acceptance of this loss as the only way they can increase a particular technology. These long-term corporate considerations are often not understood by an Air Force SPO considering a multi-year buy (22).

Greater emphasis must be placed on the requirements for a program to be a multi-year candidate. These requirements are contained in Carlucci's Initiatives and include stability of requirement, stable configuration, and a high degree of confidence in contractor capability. ACC staffers feel that programs in which production rates, total quantities, engineering technologies, and funding levels are constantly changing should not be considered as MYP candidates (13).

Key Variables

ACC staff members identified four areas where costs could be avoided if a multi-year contract were employed rather than an annual contract. These areas include subcontractor quantity discounts, direct material EOQ savings, reduced manufacturing set-up costs, and inflation avoidance (13,22).

Prime contractors could let contracts to subcontractors for quantities over a number of years and pass on those savings resulting from the lower subcontractor bids to the Air Force. These subcontractor quantity discounts could conceiveably be the largest areas of cost savings. In the same way, direct materials could be purchased from vendors at quantity discounts by the prime contractor (13,22).

In the manufacturing area, contractors can buy "heavy" tooling and equipment early in the production program, incurring high initial costs. This capital investment would reap returns greater than the initial investment at an earlier point in time (22).

Finally, buying direct materials and subcontracting early "catches" prices before they get a chance to rise again (13).

As was mentioned earlier, the ACC staff office workers do not make program office estimates. Their

identification of key variables is therefore based more on theory than practice.

F-16 Program Office

Program Overview

Currently the F-16 program is a four-year directed multi-year buy from FY82 through FY85. The delivery rate shall be ten aircraft per month for a total quantity of 480 F-16s. General Dynamics (GD) of Fort Worth is the prime contractor, and GD buys subsystems from forty-three major subcontractors (17).

MYP Estimating Environment

In the early stages of the production program, MYP was recognized as a way to "stabilize" the F-16 program. Because they recognized the potential for a long-term contract, officials at GD let long term contracts (requests for bids) to all the major subcontractors for the full quantity of 480 prior to the awarding of a multi-year contract by the Air Force. This potential for a long term contract rose out of the fact that the Air Force was committed to deliver F-16s to Israel and Europe for a number of years. This in combination with the fact that Air Force officials recognized MYP as a way to stabilize the F-16 program (as opposed to recognizing the stable F-16 program as a viable MYP candidate) led to the awarding of a MYP

contract that was almost fully anticipated by the prime contractor. GD got a "head start" on MYP cost savings which it was able to pass along to the Air Force (17).

Key Variables

F-16 cost estimators identified three major areas of cost savings resulting from the awarding of a multi-year rather than an annual contract. These key variables include Manufacturing and Engineering savings, Vendor Procurement savings, and Inflation avoidance (10:6).

Manufacturing - Manufacturing improvements identified by the contractor at GD that were projected to save costs include set-up time reduction, expansion of the one-man-multiple machine concept, maintenance of an adequate backlog level, improving inventory control procedures, and reducing the number of part orders made annually (14). In addition, the SPO identified savings resulting from reduced engineering man-hours and scheduling and tooling improvements. Generally speaking, savings occur in the manufacturing area primarily because a multi-year environment stabilizes a program and allows the contractor to streamline many of the manufacturing task centers to schedule an even flow of work. Savings occur in the engineering area as a result of the reduced man-hours required in a stable, non-fluctuating program (14:79).

The five manufacturing improvements identified by GD are projected to save over $14.8 million (14). An explanation of these areas follows.

Set-Up Time Reduction - The amount of time it takes GD manufacturing to prepare to produce pieces of hardware, including preparing materials, setting guages, and adjusting for a desired quantity, will be reduced. Set-up time in the machine shop, where sheet metal is cut into useable pieces, would be reduced by 99 hours for 149 different parts over the life of the multi-year contract. This would result in savings of 14,750 hours over four years. Reduced set-up time for 390 of those newly-created sheet metal parts could save 390 hours per part over four years. Resultant savings would be 11,857 hours. In addition, all drop-hammer and stretcher formed parts created from those pieces of machined sheet metal could be made in shipsets at a total quantity of 480, rather than the current practice of repeatedly setting up each new annual order.

Drop hammer set-up time = 1.5 hours.

225 jobs requiring set-up over the 4-year MYP period saves 1500 hours.

Stretcher set-up time = 2 hours.

300 jobs requiring set-up over the 4 years saves 2114 hours.

The total savings resulting from a reduction in set-up time would be 30,621 hours (14:17a).

One-Man-Multiple-Machine Concept - A more stable program would better define a worker's tasks in the manufacturing area. A multi-year commitment will allow the factory to run multiple machines per operator. Factory layouts have been changed and will be revised on a continuing basis to permit more suitable work places for this type of operation. The employee will be considerably more efficient and reduce the cost per piece completed. Whenever feasible, machines in the N/C area will be operated through lunch and breaks. This will also increase machine utilization. This decreased manpower would result in 181,000 hours saved over four years. However, one-third of those savings would be lost due to "trial runs", N/C tape considerations, and other inefficiencies. Total projected savings resulting from the one-man-multiple-machine concept implementation would be 119,988 hours.

Maintenance of An Adequate Backlog Level - The availability of raw materials and parts in the manufacturing area has an influence on worker productivity. Maintenance of an adequate backlog level and buffer stock in each task center would improve worker morale and, therefore, productivity. If just a little backlog exists, workers will slow down and not be concerned about finishing up the existing backlog (since if they did so, they would have nothing to do and no reason to get paid)! Savings resulting from increased productivity

of people stem from the improved morale such people have. Total savings resulting from improving worker efficiency by 3% = 120,007 hours (14:208).

Improving Inventory Control Procedures - Improving material inventory control procedures to allow adequate lead time to vendors that supply integral sub-assembly materials and parts would result in savings of 7500 hours (14:210).

Part Order Reductions - Savings would result from reducing the number of part orders and subsequent lot numbers made annually from 4 to 3, therefore necessitating larger order quantities. This would reduce part set-up requirements and shop order costs by approximately 25%. Resulting labor hour savings would be 24,400 (14:220).

These are five areas where labor savings may be realized as identified by the prime contractor and approved by the SPO.

Converted dollar savings to the Air Force are calculated below using approved wrap rates (adjustments to the costs to the Air Force considering contractor administrative costs, insurance, profit, and other contracting costs). All costs are reflected in FY82 dollars (14).

A. Set-up time reduction savings

FY	Labor rate/hr		Drop hammer set-up		Stretcher set-up		Machine shop set-up		Sheet metal	Total Savings $82 / TY$
'82	$34.35	X	660	+	742	+	3688	+	2964	
'83	$35.24	X	660	+	628	+	3688	+	2964	279806/328071
'84	$35.56	X	602	+	400	+	3688	+	2964	272176/372086
'85	$35.35	X	192	+	130	+	3688	+	2964	246531/396083

Total Then-Year Savings: $1,372,734

B. One-man-multiple-machine savings

FY	Labor rate/hr		Labor hrs saved	Total TY$ Savings
'82	34.33	X	29,997	
'83	35.24	X	29,997	1,249,444
'84	35.56	X	29,997	1,458,253
'85	35.35	X	29,997	1,703,657
			Total:	$5,441,151

C. Improved worker efficiency savings

FY	Labor rate		Annual labor hours		Efficiency Impr'ment	Total TY$ Savings
'83	35.24	X	1,609,709	X	.03	2,011,443
'84	35.56	X	1,375,081	X	.03	2,005,417
'85	35.35	X	1,482,099	X	.03	2,525,241
					Total:	$6,542,101

D. Improved inventory control schedule savings

FY	Labor rate		Labor hrs saved	Total TY$ Savings
'83	35.24	X	2500	104,131
'84	35.56	X	2500	121,533
'85	35.35	X	2500	141,986
			Total:	$367,650

E. Reduction in annual part order savings

FY	Labor rate		Reduced Admin hrs	Total TY$ Savings
'82	34.33	X	6092	
'83	35.24	X	6092	253,746
'84	35.56	X	6092	296,152
'85	35.35	X	6092	345,990
			Total:	$1,105,026

Totals, 5 contractor-identified areas of savings:

Manufacturing	$11,150,649
Inflation	3,678,013
Total:	$14,828,662

The remainder of the $50.6 million savings includes $8.8 million savings in engineering manhours (savings + inflation) plus $27 million which is additional cost avoidance due to reduced set-up costs and early implementation of all tooling reduced set-up costs and early implementation of all tooling improvements (17).

Totals, Manufacturing savings (Then-year dollars)

5 contractor-identified areas	$14,828,662
Engineering manhours	8,771,338
Scheduling, tooling improvements	27,000,000
Total:	$50,600,000

Tooling improvements have already been accomplished for the FY '82-85 multi-year contract. The $27 million cost avoidance represents the estimated savings resulting from tooling up quickly and efficiently with all tooling improvements and repairs in FY'82 (17).

Vendor Procurement - This major portion of cost avoidance accounted for 80% of the total savings estimated under a multi-year environment. Contractor estimates of $263 million and SPO estimates of $206.2 million in savings were submitted in July 1981 (10:6).

Two major areas of cost avoidance (key variables) contribute to the overall figure. Procurement of subsystems from all major subcontractors at economic order quantities (EOQ) result in the first and largest area of savings. General material procurement at quantity discounts results in the second area of savings.

Subcontracted subsystems - Prior to the awarding of a multi-year contract, the F-16 prime contractor requested bids from each of its 43 major subcontractors who build the major subsystems of the F-16. Bids came back reflecting a quantity discount if the prime were to order more than one year's quantity at a time. In effect, the prime had set up an environment with its subs where it could realize the cost benefits of EOQ procurement and pass those savings along to the Air Force should a multi-year contract be awarded (17). The following sample bid chart reflects the fact that the larger the order quantity placed at one time, the greater the savings.

Table 1

Quantity Rate Adjustment

Shipset Quantity	Price Adjustment
90 - 119	+ 0.7%
120 - 199	No change
200 - 249	- 2.6%
250 - 319	- 4.3%
320 - 399	- 5.3%
400 - 599	- 6.7% - discount at a quantity of 480
600 - 799	- 7.1%
800 +	- 7.7% (10: atch 2)

Since the F-16 SPO had planned on buying 120 aircraft per year for four years, a multi-year contract over the same time period would call for the procurement of 480 aircraft and, therefore, 480 sets of subsystems. Savings at the subcontractor level accrue in the area of manufacturing and engineering, leading to cost avoidance that could be passed from the subcontractor to the prime, and finally to the Air Force. The magnitude of the estimated savings in this area was included in the subcontractor bids. Savings to the Air Force were calculated by multiplying the subsystem unit cost x 480 x % quantity discount for a quantity of 480 for each subcontracted subsystem (17).

A unique characteristic of the F-16 subcontracted subsystem environment concerned the fact that the contracts containing those original unit prices for subsystems were due to expire in late 1981, just about the time the F-16 was being seriously considered as a multi-year candidate. The re-negotiation that took

place on those subsystems resulted in lower unit costs. Some subsystems were recompeted while others were simply procured at a quantity discount with the guarantee of a multi-year contract. The knowledge of an upcoming multi-year contract award may have influenced the degree of competition for subsystems. Thus, the anticipation of creating a multi-year environment was partially responsible for lowering subsystem unit costs in re-negotiations in late 1981 (17). Savings to the government in this area can be computed by comparing the differences in the pre and post re-negotiation unit prices x 480 x some portion of the total, say 50% (to account for the fact that that re-negotiation would probably have lowered unit prices anyway).

The following chart compares the unit prices of major subsystems before and after the 1981 re-negotiating period (12).

Table 2
Pre- and Post-Negotiation Unit Prices
FY'82 $

WBS Element	Pre-Neg Unit Price	Post-Neg Unit Price
Nose Radome	10,283	10,051
Antiskid	7,170	6,798
40 KVA Generator	6,919	6,243
Inverter	7,401	5,286
Engine Starting System	96,680	80,973
Turbine Compressor	6,214	5,808
Primary/Second Heat Exch	12,797	12,415
Stick Force Sensor	10,240	7,950
Accelerometers	5,846	4,320
Pneumatic Sensor	10,921	9,261
Ice Detector	1,539	1,495
Leading Edge Flap Drive	49,984	48.062
Channel Frequency Ind'or	3,362	2,886
Interference Blanker	5,375	5,054

Thus subsystems subcontracted under a multi-year environment offered savings in two areas in the F-16 program, quantity discounts and decreases in unit prices resulting from re-negotiation.

Of the $206.2 million savings realized in the area of Vendor Procurement, roughly two-thirds of those savings can be attributed to quantity discounts and lower re-negotiation unit prices (17).

General Material - Three types of general material acquired from vendors were identified in the F-16 program, purchased parts, standard hardware, and raw material. Purchased parts were procured similarly to subsystems and resulted in similar savings. Quantity discounts resulted in the savings realized in the procurement of standard hardware and raw materials. Over 70% of the general material was competed to arrive at the lowest cost to the Air Force (10:6).

Of the $206.2 million savings realized in the area of Vendor Procurement, one-third of those savings can be attributed to the multi-year procurements of general material. Actually, the SPO identified the $206.2 million of Vendor Procurement savings but did not break that number out. Portions attributable to the two areas of subcontracted subsystems and General Material were arrived at by observing similar percentages of total Vendor Procurement savings estimated by the prime contractor (15).

Key Variable	Resultant Savings (then-year $)
Vendor Procurement	206.2 mil.
Subsystems	136.9 mil.
Quantity discounts	
Lower re-negotiated unit prices	
General Material	69.3 mil.
Purchased parts	
Standard hardware	
Raw material	

Inflation Avoidance - Since all F-16 cost data on MYP is reflected in then-year dollars, the inflation savings has been built into the numbers and has not been separately broken out. Using a base year of 1980, OSD has approved the following inflation indices particularly for the F-16 program (17).

FY '80 to TY $

FY	Index
82	1.3803
83	1.4495
84	1.5199
85	1.6110

From the indices one can see that the procurement of subsystems, general material, and manufacturing and engineering labor and tooling earlier in the program can save money.

Annual vs MYP estimate (then-year millions of dollars) (10:4)

F-16 quantity = 480

Program Element	Annual Contract	MYP Contract	% Savings
Total Program	2892.3	2635.5	8.9

B-1B Program Office

Program Overview

Currently the B-1B program is a four year directed annual buy from FY 83 through FY 86. Production began in January of 1982 and will last through 1986 for a total quantity of 92 aircraft. However, current budgetary estimates assume MYP starting in FY83 for a total of 99 aircraft. The decision to implement a MYP contract will be made in the Fall of 1983 (28). Four prime contractors make the major systems on the B-1B. Rockwell International has the airframe contract, General Electric has the engine contract, Boeing Aircraft Corporation was awarded the contract for offensive avionics, and AIL was awarded the defensive avionics contract.

MYP Estimating Environment

Although a good deal of MYP estimating data is currently being generated, access to that data is restricted. The entire MYP Justification Package is negotiation sensitive and the B-1B SPO has requested that as few numbers as possible be included in this thesis.

The FY'83-86 MYP estimate lists savings to be incurred in FY'83. However, the timing of a MYP

contract award may be such that it will be too late to realize savings in FY'83 (28).

Each of the four prime contractors will pass on savings to the Air Force, and the key variables identified by the four primes do differ. While Rockwell, the airframe prime contractor, identified design and engineering efficiencies as a key variable, the prime contractor for the engine, General Electric, ignored design and engineering but did identify tool design efficiencies as a key variable. Manufacturing, design, and engineering efficiencies accounted for only 1.3% of the savings estimated for the defensive avionics prime contractor; that same key variable accounted for 46.7% of the cost savings estimated for the offensive avionics prime contractor. The large differences between these percentages are due to the differences between the MYP cost savings estimating methodologies employed by the two contractors as well as various unique characteristics of the contracts (5).

Key Variables

All four prime contractors will experience cost savings in the general areas of Vender Procurement/ Raw Materials, Manufacturing, Design/Engineering, and Inflation. The degree to which these key variables will lead to cost savings will differ with each of the primes, however.

Vendor Procurement/Raw Material - All four prime contractors will experience cost savings that they will be able to pass along to the Air Force resulting from quantity discounts and EOQ buys of subcontracted systems and raw material. This area offers the largest cost savings among the key variables. Reasons for those cost savings are similar to those cited in the previous section on the F-16. Generally, improved shop planning, a stable aircraft configuration, reduced set-up charges, and an accelerated delivery schedule will all lead to cost savings resulting from procurement of subcontracted subsystems. Accelerated delivery schedules and bulk transportation will be the major contributors to the cost savings associated with the procurement of general material. Estimated savings resulting from the vendor procurement and raw materials key variables represented 44% of the total estimated savings for the four contract (5:12).

The MYP Justification Package identifies three general impacts of MYP on the Defense Industrial Base in the vendor procurement/raw material area that lead to cost savings (5:16).

1. MYP allows a contractor to place contracts with subcontractors considering lead times, investment, shelf life, etc. The resulting increased interest of vendors in a more stable business base will lead to increased competition.

2. Termination protection in the out-years will increase capabilities of established vendors and lead to increased production capacity.

3. MYP helps vendors maintain adequate tooling levels, retain skilled labor, maintain affordable technicians, etc. This continuity will lead to more efficient production methods.

Manufacturing - The continuity mentioned above will also lead to lower costs in the manufacturing area. The awarding of a multi-year contract will lead to methods studies, changes in tooling concepts, and long-range manpower considerations that should decrease costs associated with shop planning.

Larger lot sizes and the resulting decrease in set-up efforts will decrease costs associated with larger releases of raw materials and work-in-process.

Productivity will increase with the awarding of a multi-year contract. Longer runs in each fabrication shop will speed up the learning process of workers and reduce set-up efforts. Assured parts availability resulting from earlier and larger material procurements would reduce snags in the production line (adequate buffer stocks). Along the same lines, larger subassembly quantities would cause a smoother flow of work. Finally, a stable configuration minimizes rework, scrappage of parts, and overtime (5:8).

The MYP Justification Package identified one impact of MYP on the Defense Industrial Base that would lead to cost savings. MYP promotes a stable business base, reduces overhead, and fosters economies of scale that are more in line with commercial practice. This allows B-1B to be more competitive in the competition for corporate investment funds (5:12).

Estimated savings resulting from the Manufacturing Key Variable represent 13% of the total estimated savings for the four contracts.

Design/Engineering - The fact that the B-1B configuration is stable will lead to decreased costs resulting from the design/engineering effort. Reductions in ECP preparation and Class II engineering changes together with easier supplier coordination and configuration management will reduce the engineering manhours required (5:10).

Inflation Avoidance - The ability to buy materials and labor earlier in the program before the prices go up leads to significant cost savings. This key variable accounts for about 37% of the cost savings realized by each prime contractor.

Individual Prime Contractor Key Variables (5:13)

Airframe - Rockwell International

Key Variable	% of Cost Savings Attributable to Airframe
Vendor Procurement/ Raw Materials	48.6
Manufacturing	8.1
Design/Engineering	5.7
Inflation Avoidance	37.6
	100.0

All key variables identified with the airframe lead to the identified savings for reasons identified in the previous section. EOQ procurements of subsystems and general material were identified as the major reasons why a multi-year contract would save airframe costs.

Defensive Avionics - AIL

Key Variable	$ of Cost Savings Attributable to Off Avio
Vendor Procurement/ Raw Materials	53.5
Manufacturing/Engineering/ Design	1.3
Inflation Avoidance	36.4
Other	8.8
	100.0

Although key variables are identified differently for AIL, the reasons why those key variables lead to cost savings are the same. Like the airframe contract, the major area of savings in the Defensive Avionics contract is subsystems and raw material procurement efficiencies. Savings in the area of manufacturing and engineering are usually small; reasons for this are not explained by the estimators, but they do cite larger runs in the fabrication shops as reasons

for those savings. Other key variables identified in the Defensive Avionics contract relate to re-scheduling of certain funding options which would reduce administrative efforts and set-up costs other than those in the manufacturing area.

Offensive Avionics - Boeing Corporation

Key Variable	$ of cost savings Attributable to Off Avio
Vendor Procurement/ Raw Materials	20.8
Manufacturing	42.9
Design/Engineering	3.8
Inflation Avoidance	32.5
	100.0

Savings realized by Boeing in the Vendor Procurement/Raw Materials area result for the same reasons mentioned previously. Integration and testing of avionics subsystems is much more complex than the I&T of airframe parts, so a commitment to long range production would lead to a more efficient, standardized avionics I&T effort in the manufacturing area. Estimators predict that this would account for nearly half of all savings resulting from MYP. They claim that the development of optimum build schedules would lead to reduced set-up costs, improved facility utilization, and a reduction in industrial engineering and test equipment. This manufacturing key variable accounts for far more savings in the Offensive Avionics contract than in any other contract.

Annual vs MYP Estimate (percentages) (5:10)

B-1B quantity - 92 Program Element	Annual - % of total contract	MYP % Savings over annual
Airframe	60	10.9
Offensive Avionics	11.3	9.2
Defensive Avionics	10.6	7.1
Engine and Spares	18.1	9.4
TOTAL	100	10.0

KC-10 Program Office

Program Overview

Currently the KC-10 program is a five year directed multi-year buy from FY'83 to FY'87 for a total quantity of 44 aircraft. Prior to FY'83 the KC-10 was procured under annual contracts. McDonnell Douglas Corporation is the prime contractor for the KC-10 (27).

MYP Estimating Environment

The KC-10 aircraft is a military version of the commercial DC-10, which has been produced for sales to commercial airlines. As a result of this previous production, the Air Force will not realize the cost savings in the manufacturing area as a new program would. Not only have commercial DC-10s been produced for some time, but 16 KC-10s had been delivered prior to FY 1983 and the start of the multi-year contract (27). This early effort and the commercial aspects of the DC/KC-10 production program have resulted in very restricted areas of cost savings. Most of the "learning" that occurs in a new program in the manufacturing areas has already taken place in the current KC-10 program.

Many of the subsystems of the KC-10 are the same subsystems used on the commercial DC-10. McDonnell Douglas keeps a fairly large inventory of these

subsystems in anticipation of future commercial DC-10 buys. A MYP environment prompts the SPO to purchase these subsystems from the contractor early in the program and in large quantities. The large inventories maintained by McDonnell Douglas were not initially created in anticipation of an Air Force multi-year buy, but the awarding of an MYP contract will lead to cost savings to the Air Force resulting from buying out those large inventories (27).

Savings projections can only be rough estimates for this program, since the SPO receives no cost data from the contractor. This military buy-in to a commercial venture was initially managed by the Air Logistics Division (ALD) and only since February of 1982 has been under the management of ASD. Such programs receive no cost data from contractors (27).

Key Variables

KC-10 cost estimators identified four primary areas of cost savings resulting from the awarding of a multi-year contract. These areas include hardware price adjustments, economic price adjustments, commercial discounts, and inflation avoidance (19:6).

Both the airframe and the engine subsystem procurement efforts will experience savings by contracting to buy these subsystems before their prices rise. When the KC-10 annual contract was initially awarded, a

general commercial airframe base price increase of approximately $1.5 million was not included. In the current MYP, McDonnell Douglas will include this increase on some of the aircraft, but not all of them, thus generating savings over an annual buy that would pick up the increase on all of the aircraft. Savings resulting from contracting for airframes early and receiving the resulting price adjustments are estimated to total $15 million over the life of the multi-year contract (19:6).

In the same manner, savings will be experienced in engine procurements. Since the award of the KC-10 contract in December of 1977, the base price of the General Electric engines has increased. These increases have been levied on commercial customers but not on the Air Force due to the fixed prices in the contract. If the current contract or this multi-year derivative is not used to buy out the total requirement, the price increase will be assessed. Savings resulting from receiving the engine price adjustments will total $132 million over the life of the multi-year contract (19:6).

In addition to these hadrdware price adjustments, KC-10 cost estimators identified economic price adjustments as areas of savings. An adjustment to the economic price adjustment formula for fringe benefits has been recognized throughout the airline industry

for several years. Savings occur in that this is not included in the current KC-10 contract and will not be assessed in this multi-year derivative of the current contract, but would be included under an annual buy contract. Savings resulting from economic price adjustmets will total $93.0 million over the life of the contract (19:6).

While price adjustments lock in a current price over a number of years so that price will not rise, commercial discounts give a special lower price to the Air Force for buying KC-10s in quantity. A commitment to buy a large quantity of KC-10s will result in a considerably lower price the Air Force will have to pay for those aircraft. Discounts are given only on the airframe and range from $4 million to $10 million per aircraft. A buyout of the KC-10 program on this multi-year derivative contract will result in a maximization of the discounts received. An Air Force commitment to buy the 44 KC-10s on a multi-year contract will result in commercial discounts totalling $164 million (19:6).

The following Unit Price Matrix (UPM) illustrates the extent to which commercial discounts on the airframe would lead to cost savings on a multi-year contract (21:3).

Annual vs MYP Estimate (TY $Mil)
KC-10 quantity - 44

Program Element	Annual Contract	MYP Contract	% Savings
Total Program	3896.0	3290.0	15.6

Table 3

Unit Price Matrix - KC-10

a KC-10 Fuselage No.	b Commercial Airframe Base Price	+	c KC-10 Peculiar Base Price	-	d Airframe Discount	=	e Net Airframe Base Price	+	f Engine Base Price	=	g Total Net Base Price
2	27,450,176		6,273,074		9,600,000		24,123,250		6,071,169		30,194,419
3	27,450,176		4,298,949		9,600,000		22,149,125		6,071,169		28,220,294
4	27,450,176		3,796,353		9,600,000		21,646,529		6,071,169		27,717,698
5	27,450,176		3,430,452		10,000,000		20,880,628		6,071,169		26,951,797
6	27,450,176		3,182,489		10,000,000		20,632,665		6,071,169		26,703,834
7	27,450,176		2,995,410		10,000,000		20,445,586		6,071,169		26,516,755
8	27,450,176		2,759,851		10,000,000		20,210,027		6,071,169		26,281,196
9	27,450,176		2,545,416		10,000,000		19,995,592		6,071,169		26,066,761
10	27,450,176		2,343,557		10,000,000		19,793,733		6,071,169		25,864,902
11	27,450,176		2,186,468		10,000,000		19,636,644		6,071,169		25,707,813
12	27,450,176		2,055,843		10,000,000		19,506,019		6,071,169		25,577,188
13	27,450,176		1,975,004		10,000,000		19,425,180		6,071,169		25,496,349
14	27,450,176		1,904,152		10,000,000		19,354,328		6,071,169		25,425,497
15	27,450,176		1,850,085		10,000,000		19,300,261		6,071,169		25,371,430
16	27,450,176		1,800,991		10,000,000		19,251,167		6,071,169		25,322,336
17	27,450,176		1,763,665		10,000,000		19,213,841		6,071,169		25,285,010
18	27,450,176		1,717,417		10,000,000		19,167,593		6,071,169		25,238,762
19	27,450,176		1,677,906		10,000,000		19,128,082		6,071,169		25,199,251
20	27,450,176		1,641,721		10,000,000		19,091,897		6,071,169		25,163,066
21	27,450,176		1,298,939		4,000,000		24,749,115		6,071,169		30,820,284
22	27,450,176		1,298,939		4,000,000		24,749,115		6,071,169		30,820,284
23	27,450,176		1,298,939		4,000,000		24,749,115		6,071,169		30,820,284
24	27,450,176		1,298,939		4,000,000		24,749,115		6,071,169		30,820,284
25	27,450,176		1,298,939		4,000,000		24,749,115		6,071,169		30,820,284
26	27,450,176		943,753		4,000,000		24,393,929		6,071,169		30,465,098
27	27,450,176		943,753		4,000,000		24,393,929		6,071,169		30,465,098
28	27,450,176		943,753		4,000,000		24,393,929		6,071,169		30,465,098
29	27,450,176		943,753		4,000,000		24,393,929		6,071,169		30,465,098

KC-135 Re-Engining Program

Program Overview

The F-108-CF-100 engine is currently procured by the Air Force as Contractor Furnished Material (CFM) through the Boeing Military Airplane Company on an annual basis. An MYP that would have allowed the Air Force to procure the engines directly from the prime contractor for FY 1984 - 1987 was rejected. Procurement of 1076 of the F-108-CF-100 engines was begun in 1982 and is scheduled to be transferred to the Air Force Logistics Command (AFLC) in 1985 (32).

MYP Estimating Environment

The F-108-CF-100 engine is a commercially produced engine proposed for use on the DC-8 and B-737 airplanes (4:2). Although the engine has not yet been produced, the benefits to the Air Force a MYP would offer would be somewhat limited. As is common with commercially produced engines, the F-108-CF-100 is flat-priced rather than cost-priced. That is, the prices of the first engines made do not differ significantly from the prices of units produced later. Thus while contractor costs to produce engines are higher for those engines made earlier, consistent with learning curve theory, the prices those contractors charge for the early engines must be low enough to attract buyers.

At the front end of the program, the contractor will be pricing at or below cost to attract those buyers (32).

While a multi-year contract would guarantee the prime contractor business for four years, those benefits are also experienced by virtue of the fact that projections of commercial DC-8 and B-737 sales are made three years into the future. Thus the prime contractor is already gearing up for a long-term production effort with a relatively solid commitment from commercial aircraft companies (4:8).

Since the KC-135 re-engining effort will be transferred over to AFLC in 1985, 1984 is the last year a multi-year contract could be negotiated. However, a request to get on a multi-year contract was denied, so the program will continue as an annual buy effort.

Key Variables

Estimators in the engine SPO identified numerous sources of savings resulting from the awarding of a multi-year contract. The magnitude of these savings, however, could not be disclosed because of commercial pricing practices. The prime contractor offered the Air Force a 5% concession in consideration for an improved and stabilized production program. Engine SPO estimates set 4.5%, or $119.2 million, as the total projected cost savings. This SPO estimate is based

on a prime contractor "management decision" to give the Air Force that 5% discount consisting of savings in the areas of vendor procurement, manufacturing, design/engineering, tool design, support equipment, and inflation avoidance (4:8).

Impacts on the Defense Industrial Base recognized by the SPO in this particular program include improved competition, enhanced investment, improvement in vendor skill levels, progress payment changes, and increased production capacity (4:11).

A significant production increase under the multi-year program would result in increased long range orders for both General Electric and SNECMA suppliers. Both suppliers would almost certainly expand the number of vendors they would get on contract. Although the commercial base of the F-108-CF-100 program already has the previously mentioned elements of MYP, a commitment to such a large scale program provides stability and should still encourage additional contractor and vendor investment. Reductions in scrap, rework, and delays could occur if parts are scheduled optimally on higher rate machines, improving vendor skill levels. Accelerating payments to the prime contractor by incorporating an incremental billing arrangement would improve progress payment methods by allowing the prime contractor to spend more money up-front. Finally, production capacity will be increased through qualification of

additional vendors and increased production of existing vendors and at the contractors' plants. Although these impacts on the Defense Industrial Base have been identified by the SPO, no corresponding cost savings have been generated (4:12).

Annual vs MYP Estimate (TY $ Mil)

F-108-CF-100 engine quantity = 1076

Program Element	Annual Contract	MYP Contract	% Savings
Total Program	2667.5	2548.3	4.5

GAU-8 30mm Ammunition Program

Program Overview

The 30mm ammunition program is currently managed by AFLC. A multi-year contract was let for a quantity of 25.0 million rounds from FY 80 to FY 82. Prior to that multi-year contract, competitive annual buys had taken place since 1976. Both Honeywell, Inc. and the Aerojet Ordnance Company have been the competitive prime contractors on this program since 1976 for both the annual and multi-year contracts (24).

MYP Estimating Environment

Prior to the development of the 1981 DOD Authorization Act, MYP was severely restricted. The $5 million cancellation ceiling posed a risk to contractors that was too often unacceptable. In addition, recurring costs

such as advanced buys of materials could not be compensated for by the government; contractors could not get reimbursed for these unused materials. The 30mm Ammo SPO requested a waiver from many of these restrictions and received one for the 1980-82 multi-year buy. The cancellation ceiling was raised to $36 million to protect the contractors from such risks (1).

By the time a multi-year contract for 1980-1982 was awarded, Honeywell had already produced close to 9.8 million rounds of 30mm ammunition and Aerojet had produced nearly 5 million rounds (3). These large quantities of previously produced hardware severely restricted any decreases in cost that may have been experienced by a "learning curve" effect. The following chart illustrates that the previous competitive buys and large quantities of bullets produced by each contractor resulted in a minimal recurring unit price decrease with the experience of a multi-year environment starting in 1980; all previous learning and the resulting price decreases took place prior to the awarding of the multi-year contract (2).

Key Variables

SPO estimators identified three areas of cost savings resulting from the awarding of a multi-year contract. Those areas include major subcontractors and advanced material buys, manufacturing and labor efficiencies, and design/engineering stability (3).

Although competition would stimulate some savings, that amount would be so small that the estimators did not mention it.

Although these three key variables are cited, any thorough documentation to accompany their explanations does not exist. As was mentioned earlier, no MYP Justification Package had to be developed prior to the awarding of a multi-year contract, so detailed explanations of key variables were not created.

Advanced buys of materials and major subcontracted subsystems would lead to savings primarily because the prime contractors could solicit bids for larger quantities. Included in this key variable would be the inflation avoidance resulting from advanced buys. SPO estimators felt that 60% of the total cost savings resulting from a multi-year buy would be attributable to major subcontractor and advanced material buys. This amounted to $20.3 million (3).

Manufacturing and labor efficiencies would lead to savings of $6.8 million, or 20% of the total cost savings (3). These savings result primarily because production and delivery schedules become compressed and re-organization of the manufacturing shops to yield the maximum rates of production efficiency takes place.

Design/engineering stability had taken place early in the program since the 30mm bullet is a relatively simple piece of hardware. However, SPO estimators

still felt that another $6.8 million could be saved by standardizing the design, thus requiring fewer engineers and reducing labor costs (3).

Annual vs MYP Estimate (TY $ Mil) (3)

30mm ammunition quantity - 25 million

Program Element	Annual Contract	MYP Contract	% Savings
Total Program	363.5	321.0	11.7

CHAPTER IV

ESTIMATING MYP COST SAVINGS AT ASD

The following table illustrates the magnitude of cost savings resulting from the awarding of a multi-year rather than an annual contract in the five programs included in this research.

Program	$ cost savings	% cost savings
F-16	$256.8 mil	8.9
B-1B	(negotiation-sensitive data)	10.0
KC-10	$606.0 mil	15.6
KC-135 re-engineering	$119.2 mil	4.5
30mm ammo	$33.9 mil	11.7

Cost savings are an aggregate of the savings attributable to each key variable effecting the particular program.

Key Variables

Cost estimators from five different SPOs at ASD cited a total of eleven different combinations of key variables leading to cost savings. Table 4 lists each one of those combinations and identifies the relative magnitudes of the resulting savings for each applicable program. Table 5 lists nine combinations of these eleven key variables with an <u>average</u> percentage of cost savings attributable to each combination. For example, cost

Table 4

Percentage of Total Cost Savings Attributable to Key Variables

Kay Variable/ Combination	Program	% of Total Cost Savings Attributable to that Key Variable
Manufacturing	B-1B airframe	8.1
	B-1B offensive avionics	42.9
	B-1B engine	18.8
	30mm ammunition	20.0
	KC-135 re-engining	unidentified
Manufacturing and Engineering	F-16	19.7
Manufacturing, Design and Engineering	B-1B defensive avionis	1.3
Vendor Prourement/ Raw Materials	F-16	80.3
	B-1B airframe	48.6
	B-1B defensive avionics	53.5
	B-1B offensive avionics	20.8
	B-1B engine	36.7
	30mm ammunition	60.0
	KC-135 re-engining	unidentified
Inflation Avoidance	B-1B airframe	37.6
	B-1B defensive avionics	36.4
	B-1B offensive avionics	32.5
	B-1B engine	37.5
	KC-10	33.3
	KC-135 re-engining	unidentified

Table 4 (contd)

Design/Engineering	B-1B airframe	5.7
	B-1B offensive avionics	3.8
	30mm ammunition	20.0
Tool Design	B-1B engine	3.5
	KC-135 re-engining	unidentified
Hardware Price Adjustments	KC-10 airframe	2.5
	KC-10 engine	21.8
Economic Price Adjustments	KC-10	15.3
Commercial discounts	KC-10	27.1
Support equipment	KC-135 re-engining	unidentified

Table 5

Average Percentage of Total Savings
Attributable to Key Variables

Key Variable/ Combination	Avg % of Total Cost Savings Attributable to that Key Variable	
	Military Procurement	Military Buy-In to a Commercial Program
Manufacturing	18.6	
Design/Engineering	8.1	
Vendor Procurement/ Raw Materials	41.1	
Inflation Avoidance	29.3	29.3
Tool Design	2.9	
Hardware Price Adjustments		12.2
Economic Price Adjustments		15.3
Commercial Discounts		27.1
Other Commercial Considerations		16.1
	100	100

savings in the area of Vendor Procurement/Raw Materials would account for an average of 41% of the total cost savings resulting from the awarding of a multi-year rather than an annual contract.

The manufacturing key variable leads to cost savings because shop layouts can be developed, possibly initially at a high cost, to yield maximum efficiency production processes as early in the multi-year program as possible. Over the long term, therefore, efficient production methods will lead to lower costs.

The manufacturing and engineering key variable simply combines the savings resulting from more efficient shop layouts with savings resulting from the reduction in engineering manhours required to maintain the F-16's stable configuration. With MYP comes the stability of a desired design and a minimum number of engineering changes.

The manufacturing, design, and engineering key variable considers the savings listed in the previous areas plus a small additional savings resulting from the fact that a reduction in the number of design engineers will save money. The most commonly identified key variable was Vendor Procurement/Raw Materials. Savings result in this area because prime contractors are able to solicit bids for larger quantities and from more subcontractors. EOQ buys and quantity discounts result in substantial cost savings. The

procurement of both subcontracted subsystems and direct materials lead to these cost savings.

Buying materials and subsystems before their prices have a chance to rise is the reason why cost savings are experienced in the inflation avoidance area. Although every program is not listed on the chart as experiencing cost savings from inflation avoidance, F-16 inflation savings are built into the other key variable savings as are 30mm ammunition savings.

The Design/Engineering key variable results in savings because engineering manhours will be reduced under a stable program, and MYP tends to stabilize a program.

The tool design key variable will lead to cost savings because a multi-year contract permits the contractor to install permanent "hard" tooling early in the program. This high initial investment would be more than offset by the fact that no additional tooling costs would have to be incurred throughout the life of the program. Similarities between this and the manufacturing key variable emphasize the cost benefits of a stable configuration.

The key variable identified as Hardware Price Adjustments will save the KC-10 SPO money. By putting a number of aircraft on contract over a multiple year period, the SPO is able to lock in prices before increases take place. Known price increases can thus be avoided by putting many aircraft on contract early.

An understanding of economic conditions surrounding a system's procurement can lead to cost savings identified in the Economic Price Adjustment key variable. Contractual arrangements can be made to lock in the prices of systems produced under current economic conditions before those conditions change.

The Commercial Discounts key variable leads to savings in that contractors will often offer these discounts to a "most favored customer" who is willing to commit to a large quantity purchase. The size of the discount will probably vary depending upon how many systems have already been procured.

The Support Equipment key variable was identified by the KC-135 re-engining SPO but was never explained. It probably refers to the fact that savings can be realized in the procurement of support equipment just as they can be realized in the procurement of systems.

Inconsistent Effects of Key Variables on Key Savings

Since every program is unique concerning the type of system produced, the manufacturing facilities used, the economic conditions prevalent, and other considerations, key variables will reduce costs in different programs to varying degrees.

The manufacturing key variable led to savings of between 8.1% and 20.0% on three of the four programs identified. However, the B-1B Offensive Avionics

effort is to experience a 42.9% cost savings! This inconsistency may be attributable to the fact that the Boeing Corporation does not have a great deal of experience in producing Offensive Avionics systems in its manufacturing shops. The complexity of this system will call for an extensive re-organization effort in the manufacturing shops that will significantly lower costs over the life of the program (28).

B-1B SPO estimators felt that the Defensive Avionics contractor, AIL, would only pass on 1.3% of its total cost savings in the manufacturing, design, and engineering areas together. This may be explained by the fact that AIL is already geared up to produce Defense Avionics systems and has already streamlined its manufacturing shops to a great extent (28).

Savings realized in the Vendor Procurement/Raw Materials area will vary with each program depending on the extent to which advanced buys of raw materials are made and the degree of subcontracting involved in the program. The massive subcontracting efforts involved in the F-16 program were begun by the prime contractor, General Dynamics, even before a multi-year contract had been awarded. Conversely, Boeing may be unable to advance-buy many offensive avionics materials for the B-1B and may also have let very few subcontracts. That is why 80.3% of the F-16 cost savings are attributable to this key variable while only 20.8% of B-1B

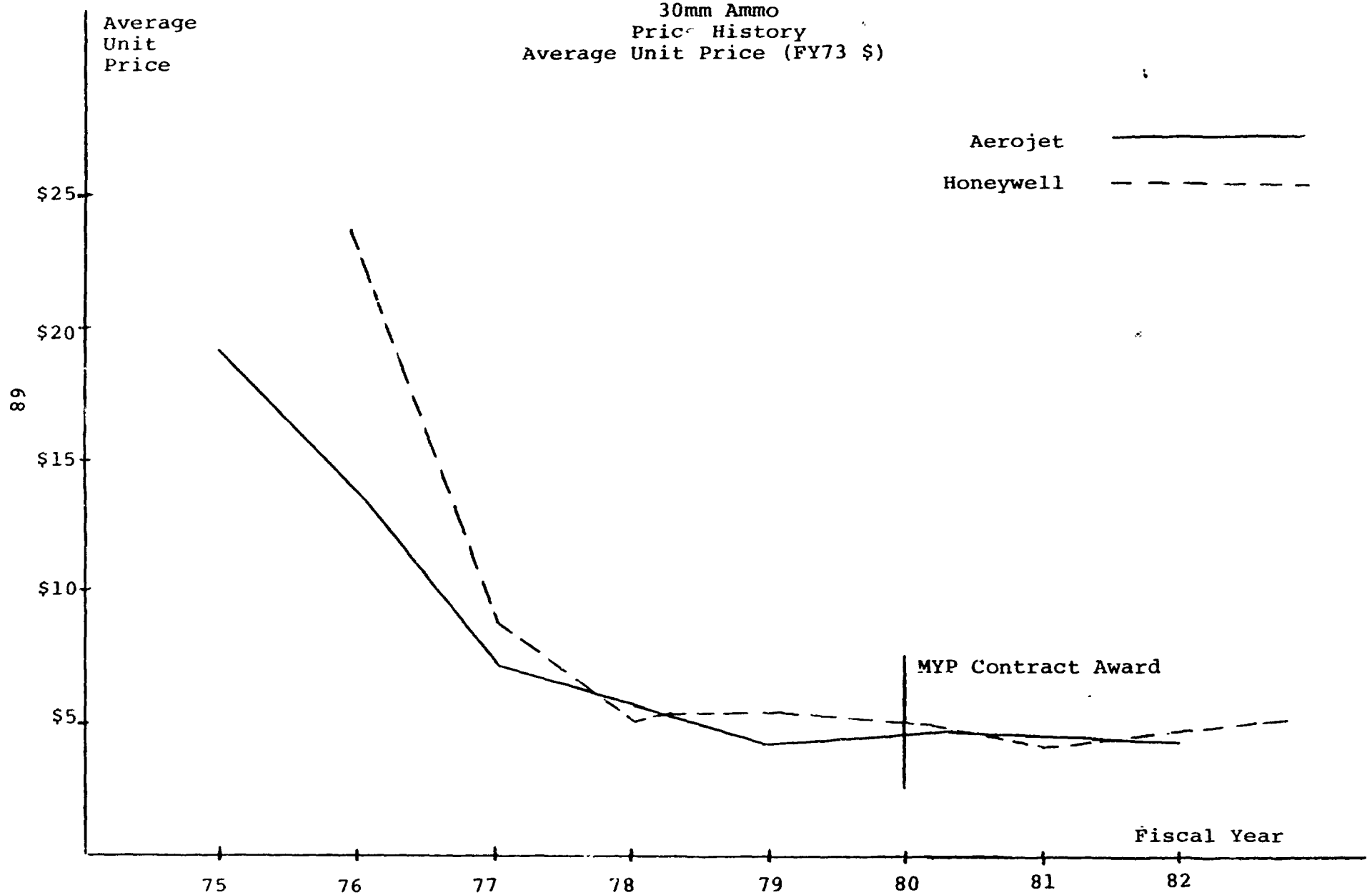
Offensive Avionics cost savings are attributable to this area. Of course, the F-16 Vendor Procurement/Raw Material savings includes inflation avoidance while that key variable is separate in the B-1B program.

Cost savings attributable to the Design/Engineering key variable are no more than 5.7% in two programs but represent 200% of the cost savings realized in the 30mm ammunition program. Since a good deal of documentation is missing on the 30mm program, a good explanation for the discrepancy can only be theorized. Perhaps the program employed an excessive number of engineers and was able to drop a large number of them upon receipt of a multi-year contract.

Hardware price adjustments accounted for 21.8% of the savings experienced on the KC-10 engine program but only 2.5% of those savings realized on the KC-10 airframe acquisition. This is because the price of engines was rising much faster than the price of airframes, so locking in a stable engine price would avoid greater price increases than locking in a stable airframe price would (21:2).

As has been illustrated, different SPOs cite different areas of cost savings. Key variables that one SPO considers may be irrelevant to another SPO. Other SPOs may mix key variables together and call them something else.

FIGURE 1


30mm Ammo
Price History
Average Unit Price (FY73 $)
Average
Unit
Price
Aerojet
Honeywell
$25
$20
$15
$10
$5
89
MYP Contract Award
Fiscal Year
75
76
77
78
79
80
81
82

Key Variables to Assess in Costing MYP

ASD cost estimators identified combinations of ten different key variables. As a minimum, the following areas of cost savings should be examined by any estimator attempting to predict the magnitude of cost savings resulting from MYP:

1. Manufacturing
2. Design
3. Engineering
4. Vendor Procurement/Raw Materials
5. Tool Design
6. Hardware Price Adjustments
7. Economic Price Adjustments
8. Discounts
9. Support Equipment
10. Inflation Avoidance

Before attempting to assess a cost savings, however, the estimator must be familiar with the many unique program characteristics that may have an effect on the extent to which a key variable is relevant to the particular program.

CHAPTER V

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

Many agencies involved with the DOD acquisition process feel that cost benefits resulting from the awarding of multi-year contracts exist. The reasons why these cost savings exist vary with each program and include some of the following program considerations:

1. Nature of the system to be procured
2. Ability/experience of the contractor
3. Economic conditions prevailing

Although cost savings can be incurred under a multi-year contract, certain characteristics should be present for the maximum savings to be realized. Those required characteristics include:

1. Stability of requirement
2. Stability of funding
3. Stable configuration
4. Degree of confidence in contractor capability

ASD SPOs supporting five different programs all cited varying degrees of cost savings. Each program was in a different phase of the procurement cycle and satisfied the characteristics required to realize maximum cost savings to varying degrees.

Data gathered to support key variables was difficult to collect because it was not standardized.

Each SPO expressed the cost savings it realizes in a different manner. It is essential that the nature of the program be understood for the data concerning key variables to be useful tools in assessing cost savings.

Recommendations

The effort expended on the development of this thesis has revealed additional areas of potential research that could prove useful to MYP cost estimators. The results of this effort constitute a first attempt to assess the areas where cost savings resulting from MYP can occur. Future research efforts may include:

1. The data base used to gather key variables could be expanded to include not only ASD SPOs but the entire Air Force acquisition arena or possibly even the entire DOD environment. In this manner key variables effecting the savings on all types of systems could be assessed.

2. An in-depth analysis of the key variables identified in one or two SPOs could be made. Researchers could solicit direct contractor as well as SPO input relating to the identification and magnitude of key variable cost savings.

3. A continuation of this effort could be done with the intent of developing an ASD MYP cost estimating model incorporating all the key variables identified here and any additional ones found at other ASD SPOs.

SELECTED BIBLIOGRAPHY

REFERENCES CITED

1. A-10 Contracting Office, Aeronautical Systems Division. GAU-8/A Ammunition Multi-Year. Briefing prepared by ASD/TAAK, 15 Jul 81.

2. _____. Working papers prepared for independent exercises, Jun 81.

3. Aeronautical Systems Division (ASD). Price Memorandum to Aerojet Ordnance Company and Honeywell, Inc. A-10 SPO, Wright-Patterson Air Force Base OH, 8 Feb 80.

4. ASD/YZA. F-108-CF-100 Engine FY84-87 Multi-Year Program Evaluation. Document prepared for ASD/AFN, 21 Jul 82.

5. B-1B Contracting Office, ASD. MYP Criteria. Document prepared for AFSC/PMP, 7 Mar 83.

6. Bergjans, Captain Steven B. and Captain Lawrence J. Elbroch. "An Analysis of the Predicted Benefits of Multi-Year Procurement", Unpublished Master's Thesis. LSSR 1-82, AFIT/LS, Wright-Patterson AFB OH, Sep 82.

7. Booz-Allen and Hamilton, Inc. "Analysis of Cancellation and Termination Aspects of Multi-Year Procurements", Unpublished research report prepared for the Defense Management College, Fort Belvoir VA, 3 Dec 82.

8. Defense Systems Management College. "Realistic Cost Estimating", Open forum chaired by DSMC and attended by numerous industry and government personnel, Naval War College, Newport, RI, 4-6 May 79. AD A080971.

9. Department of Defense. Defense Acquisition Regulation, Washington DC, 22 Feb 80.

10. F-16 Contracting Office, ASD. F-16 MYP Execution Documentation. ASD/YPK document prepared for AFSC/PMPS, 6 May 83.

11. F-16 Cost Analysis Office. FY83 BES Subcontract Estimate, ASD/YP, Jun 82.

12. F-16 Pricing Shop, ASD. F-16 Follow-On Pricing Formula Data. ASD/YPK, 25 Sep 81.

13. Frye, Thomas, Staff Cost Analyst, ASD/ACC, Wright-Patterson Air Force Base OH. Personal Interview, 6 Jul 83.

14. General Dynamics Corporation. F-16 Multi-Year Improvements. Cost proposal submitted to ASD/YP, 23 Feb 82.

15. _____. F-16 Multi-Year Contract Projected Savings. Fort Worth TX, Jul 81.

16. _____. F-16 Program Shipset Value Percent Change. Fort Worth TX, 29 Oct 81.

17. Harrah, Virginia, F-16 Cost Analyst, ASD/YP, Wright-Patterson Air Force Base OH. Personal Interview, 21 Jun 83.

18. KC-10 Airlift Program Office. Weapon System Program Estimate. Air Force Form 1537, 22 Mar 82.

19. KC-10 Contracting Office, ASD. Criteria for Selection, KC-10A. Document prepared for AFSC/PMP, Dec 82.

20. Laflow, Lieutenant Colonel Kary R. "Selecting Programs for Multi-Year Procurement", Concepts. Spring 1982, pp. 54-67.

21. McDonnell Douglas Corporation. Cost/Price for KC-10 MYP. A price proposal submitted to ASD/ , 24 Sep 82.

22. Osborne, Donald, Staff Cost Analyst, ASD/ACC, Wright-Patterson Air Force Base OH. Personal Interview, 13 Jun 83.

23. Perry, William J. "The Department of Defense Statement on Industrial Readiness", Unpublished report presented to the Defense Industrial Board Panel of the Committee on Armed Services, Washington DC, 3 Dec 80, AD A101565.

24. Prickett, David, Contracting Officer, A-10 Program Office, ASD, Wright-Patterson Air Force Base OH. Personal Interview, 17 Aug 83.

25. Procurement Logistics and Readiness Division, General Accounting Office. "GAO Analysis of Projects Proposed by the Department of Defense of Multi-Year Contracting in its fiscal year 1983 budget request", Unpublished report, General Accounting Office, Washington DC, April 29, 1982, AD A118235.

26. Richardson, J. H., President, Hughes Aircraft Company. Letter to RADM Neil P. Ferraro, USN. Assistant Commander for Contracts, Naval Air Systems Command, 31 Mar 80.

27. Root, Joanne, KC-10 Cost Analyst, ASD, Wright-Patterson Air Force Base OH. Personal Interview, 28 Jun 83.

28. Runkle, Ronald, B-1B Director of Program Control, ASD, Wright-Patterson Air Force Base OH. Personal Interview, 21 Jun 83.

29. Singer, Dr. Abraham and Colonel G. Dana Brabson. "Enhanced Multi-Year Procurement for Improving Weapon System Acquisition", Concepts, Summer 1982, pp. 112-129.

30. Slay, General Alton D., USAF. Commander, Air Force Systems Command. "Legislative and Policy Changes for Multi-Year Contracting". Letter to HQ USAF (Lt Gen Driessnack), Andrews AFB MD, 28 Mar 80.

31. Soler, Oscar. Handouts developed for a beginning course in Cost Analysis, AD/ACC, Eglin AFB FL, Jul 80.

32. Taylor, Douglas, KC-135 re-engining effort Cost Analyst, ASD/YZ, Wright-Patterson Air Force Base OH. Personal Interview, 28 Jun 83.

33. 30mm Ammunition Program Office. GAU-8 Multi-Year Procurement. Memorandum prepared for HQ USAF/RDC, 6 Mar 81.

34. U.S. Congress, House of Representatives. Committee on Armed Services and Defense Industrial Base Panel. The Ailing Industrial Base. Unready for Crisis. Report to Congress, 96th Congress, 2nd Session. Washington DC: Government Printing Office, 31 Dec 80.

35. _____. House of Representatives. Committee on Armed Services. DOD Authorization Act, 1982. Report to Congress, 1st Session. Washington DC: Government Printing Office, 19 May 81.

36. Utgoff, Kathleen P. and Dick Thaler. "The Economics of Multi-Year Contracting', Unpublished Reserach Report, Center for Naval Analyses, Alexandria VA, March 82, AD A114732.

37. Zabel, Wayne V. and Duane D. Knittle . "Improving Productivity and Reducing Cost Through Capital Investment Incentives", Unpublished research report, Army Procurement Research Office, Fort Lee, Virginia, Dec 80, AD A094681.

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